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VOL. CXLVI.—No. 3804] LONDON: FRIDAY EVENING, DECEMBER 7, 1928 [PRICE { WITH SUPPLEMENT } ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

The Director - General, India Store Department, Belvedere-road, Lambeth, London, S.E. 1, invites TENDERS for :—

SCHEDULE 1.—BOGIE TRUCKS with FITTINGS for METRE-GAUGE ROLLING STOCK.

SCHEDULE 2.—EIGHT 250 TONS HYDRAULIC TRAVERSING JACKS.

Tenders due on the 20th December, 1928, for No. 1, and on the 8th January, 1929, for No. 2.

Forms of Tender obtainable from the above at a fee (which will not be returned) of 5s. for each Schedule. 429

PROFESSOR OF MECHANICAL ENGINEERING, COLLEGE OF ENGINEERING, GUINDY, MADRAS.

Applications are INVITED for the PROFESSORSHIP of MECHANICAL ENGINEERING at the College of Engineering, Guindy, Madras.

Candidates should not be more than 40 years of age. They must hold an Honours Degree in Mechanical Engineering and have had practical experience.

Salary Rs. 1000 a month, rising by annual increments of Rs. 50 a month to Rs. 1500. An officer of non-Asiatic domicile will draw in addition overseas pay of £25 a month. Total minimum pay for officer of non-Asiatic domicile equivalent to approximately £1200 a year. Appointment on agreement for five years in first instance with possibility of extension. Free first-class passage to India for candidate and family. Strict medical examination.

Further particulars and forms of application may be obtained upon request by postcard to the SECRETARY TO THE HIGH COMMISSIONER FOR INDIA, 42, Grosvenor-gardens, London, S.W. 1.

Last date for receipt of applications 31st December, 1928. 327

Crown Agents for the COLONIES.

COLONIAL GOVERNMENT APPOINTMENTS.

APPLICATIONS from qualified candidates are INVITED for the following POSTS :—

ASSISTANT ENGINEER (M/1169) REQUIRED by the GOVERNMENT of NIGERIA *for* Road Survey and Construction for two tours of from 12 to 18 months' service, with possible extension. Salary £600, rising by annual increments to £920 a year. Free quarters and passages and liberal leave on full salary. Outfit allowance of £60 on first appointment. Candidates, age 23 to 35, should possess considerable experience of road and bridge or similar construction, surveying and levelling, and be competent to set out and supervise work and control labour.

The Officers indicated below are required for the FEDERATED MALAY STATES GOVERNMENT RAILWAY for four years; with prospect of permanency. Salary as shown below. In each case a strictly temporary cost-of-living allowance is also paid amounting to 10 per cent. of salary for single men and 20 per cent. for married men. The Government rate of exchange is now 2s. 4d. to the dollar, but the purchasing power of the dollar in Malaya is at present considerably less than that of 2s. 4d. in the United Kingdom. Free passages and, if married, for wife and children also under certain conditions.

ASSISTANT WORKS MANAGER (M/578).

Salary 600 dollars a month, rising to 800 dollars a month by annual increments of 25 dollars a month. Candidates, age 25 to 35, must have served an apprenticeship or pupilage in the Locomotive Department of a British Railway or with a firm of Locomotive Builders, and have had experience of Works Management and of Locomotive Running conditions. They must also be either an A.M.I.C.E. or a University Graduate in Mechanical Engineering.

ASSISTANT LOCOMOTIVE SUPERINTENDENT (M/1214).

Salary 400 dollars a month, rising by annual increments of 25 dollars a month to 800 dollars a month. Candidates, age 25 to 30, must have served an apprenticeship as a Mechanical Engineer in a Locomotive Engineer's Shops or Railway Locomotive Works, and should have had subsequent experience in the Locomotive Department of a Railway. They must also be either an A.M.I.C.E. or a University Graduate in Mechanical Engineering.

CHIEF DRAUGHTSMAN (M/1217).

Salary 400 dollars a month, rising by annual increments to 600 dollars a month. Candidates, age 25 to 35, must have served an apprenticeship in the Shops of a Railway or of a Firm of Locomotive or Rolling Stock Manufacturers, have spent some time in a Drawing-office. They should hold a recognised engineering qualification. Preference will be given to those who also have a knowledge of Carriage and Wagon Work.

Apply at once by letter, stating age and full particulars of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting the reference number against the appointment for which application is made. 419

The High Commissioner for India is prepared to receive APPLICATIONS for the POST of ASSISTANT SUPERINTENDENT OF STORES in the BUILDINGS AND ROADS BRANCH, PUBLIC WORKS DEPARTMENT OF THE GOVERNMENT OF BURMA. Candidates must possess a University Degree in Civil or Mechanical Engineering, or, in lieu thereof, the Diploma of A.M.I.C.E. In addition, they should have had at least two years' practical experience in the purchase and distribution of common engineering construction materials. Age should be between 25 and 30 years. Agreement for five years in first instance. First-class passage out and home. Provident Fund. Pay on age scale, e.g., for an officer of non-Asiatic domicile, age 25, Rs. 475 a month plus overseas pay of Rs. 150 a month ; 28 years, Rs. 575 plus overseas pay of £15 a month. The scale continues by increments of Rs. 50 to a maximum of Rs. 975 a month plus overseas pay of £30 a month. In addition to pay the officer will draw monthly certain local allowances. The sterling equivalent of the total emoluments drawn by an officer of non-Asiatic domicile aged 25 years would be approximately £657 per annum. At 30 years the approximate figure would be £970 p.a.

Further particulars and forms of application may be obtained upon request by postcard to the SECRETARY TO THE HIGH COMMISSIONER FOR INDIA, General Department, 42, Grosvenor-gardens, London, S.W. 1. Last date for the receipt of applications 22nd December, 1928. 348

The Engineer

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PUBLIC NOTICES

PATENTS AND DESIGNS ACTS, 1907 TO 1928.

Notice is Hereby Given that JULIUS JERIKE, of 22, Wotanstrasse, in the city of Munich, Germany, SEEKS LEAVE to AMEND the SPECIFICATION of the APPLICATION for LETTERS PATENT No. 268,812, for an invention entitled "Improved Apparatus for Measuring or Controlling Temperatures."

Particulars of the proposed Amendment were set forth in the "Illustrated Official Journal (Patents)" of the 21st November, 1928.

Any person, or persons, may give Notice of Opposition to the Amendment by leaving Patents Form No. 19 at the Patent Office, 25, Southampton-buildings, London, W.C. 2, within one calendar month from the date of the said Journal.

W. C. JARRATT,
Comptroller-General.
407

Bengal-Nagpur Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for : 16 SPANS PLATE GIRDER BRIDGES (Ten 40ft. Spans and Six 20ft. Spans).

Specification and form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after 6th December, 1928.

A fee of 10s. will be charged for each copy of the specification, which is NOT returnable.

Tenders must be submitted not later than Noon on 20th December, 1928.

The Directors do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right of reducing or dividing the order.

By Order of the Board,
R. C. VOLKERS,
Secretary.
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Great Western Railway.

The Directors of the Great Western Railway Company have FOR DISPOSAL GAS ENGINES and DYNAMOS, which can be seen in commission at Swindon.

Applications to view should be made to Mr. A. C. Cookson, the Company's Stores Superintendent at Swindon, Wilts., from whom full particulars may be obtained.

F. R. E. DAVIS, Secy.
Paddington Station, London, W. 2. 424

PUBLIC NOTICES

Clyde Navigation Trust.

TO CONTRACTORS.

The Trustees of the Clyde Navigation invite TENDERS for the CONSTRUCTION of a SINGLE-STOREY GOODS SHED at Berth No. 6, Broomielaw Quay, Glasgow Harbour, 137ft. in length, by 70ft. in width. The work embraces about 55 tons of Steel for Columns, Girders, and Roofing, and includes Brickwork, Joiner and Slater Work.

Drawings may be seen and specification, schedule of quantities, and form of Tender obtained on application to Mr. A. M. Fulton, Chief Assistant Engineer to the Trustees, at his office here, on a deposit of Two Guineas, which will be refunded on receipt of a bona fide Tender.

Sealed Tenders, marked "Tender for Shed at Berth No. 6, Broomielaw Quay," to be lodged with the undersigned not later than Monday, 17th December, 1928.

The Trustees may not accept the lowest or any Tender.

JAS. MACFARLANE,
General Manager.
16, Robertson-street, Glasgow, C. 2.
5th December, 1928. 406

Administrative County of LONDON.

REBUILDING OF LAMBETH BRIDGE.

APPOINTMENT OF A RESIDENT ENGINEER.

The London County Council invites APPLICATIONS for the POSITION of RESIDENT ENGINEER in connection with the rebuilding of Lambeth Bridge over the River Thames between Westminster and Lambeth.

The appointment will be upon the temporary staff ; selected candidate will be appointed by and serve under the direction of the Council's Chief Engineer.

The salary will not exceed £800 a year inclusive.

Candidates must be Corporate Members of the Institution of Civil Engineers. Practical experience with an engineer or contractor in control of works of bridge construction or other works of a similar character, involving the sinking of caissons under compressed air, is essential, and candidates must be physically fit to the satisfaction of the Council's Medical Examiner for compressed air work.

Forms of application may be obtained either by personal call at the County Hall (Room 216) or by sending a stamped addressed foolscap envelope, marked "Resident Engineer, Lambeth Bridge," to the Clerk of the Council, The County Hall, Westminster Bridge, S.E.1. The latest time for receiving applications is Monday, 17th December, 1928. Canvassing disqualifies.

MONTAGU H. COX,
Clerk of the London County Council.
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PUBLIC NOTICES

Municipality of Singapore, STRAITS SETTLEMENTS.

ELECTRICITY DEPARTMENT.

ASSISTANT POWER STATION SUPERINTENDENT.

ADVERTISEMENT.

An ASSISTANT POWER STATION SUPERINTENDENT (age not exceeding 42 years) is REQUIRED by the Municipal Commissioners of Singapore, for service at their new Power Station, the appointment being on the permanent staff of their Electricity Department, and being in the first instance upon a three years' agreement.

The capacity of the plant first installed was 12,000 kilowatts, with an extension of 10,000 kilowatts now in progress.

Candidates should have a thorough experience in extra high-tension three-phase generation, steam turbines, water-tube boilers and mechanical stokers and must have held a similar position previously. Possession of a First Grade Engineer's Certificate granted by the Board of Trade is desirable.

The selected candidate will be required to take shifts and, when necessary, to deputise for the Power Station Superintendent.

Strict medical examination required.

Salary, 6240 dollars, 6720 dollars, and 7200 dollars per annum respectively for the three years of the agreement, and rising thereafter, if service be continued, in accordance with the Commissioners' Salary Scheme. The exchange value of the dollar is 2s. 4d. sterling, at which rate the salary for the first year would amount to £728. There is at present no income tax. Free partially furnished quarters provided, with an allowance for lighting.

Free passage will be provided, with half salary during the voyage out, and if the selected candidate is married, passages will be provided for his wife and family (if any). Eight months' leave with full pay is normally granted after four years' service. Liberal Provident Fund.

Applications, stating whether married or single, and giving age and birthplace with details of education, training and experience, and referring particularly to the qualifications mentioned above, and accompanied by copies (not originals) of testimonials, to be lodged with Messrs. PEIRCE and WILLIAMS, MM. Inst. C.E., 64, Victoria-street, London, S.W. 1, Agents to the Commissioners, not later than Monday, 17th December, 1928.

Further particulars, if desired, can be obtained from the Agents. 416

City of Stoke-on-Trent.

ELECTRICAL ENGINEER'S DEPARTMENT.

CONTRACT NO. 2840.

TENDERS are INVITED for the SUPPLY and ERECTION of ONE ELECTRICALLY DRIVEN AIR COMPRESSOR at the Central Power-house, Hanley.

Specification and Tender form obtainable from the City Electrical Engineer, 86, George's Chambers, Kingsway, Stoke-on-Trent, on payment of £2.

Tenders should be delivered to the undersigned in the envelope provided not later than the first postal delivery on Wednesday, 16th January, 1929.

E. B. SHARPLEY,
Town Clerk.
Town Hall, Stoke-on-Trent,
4th December, 1928. 403

South Indian Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for the SUPPLY of :—

PAINT AND ENAMEL.

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Paints and Enamel," with the name of the firm tendering, must be left with the undersigned not later than Twelve Noon on Friday, the 21st December, 1928.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of 10s. for each copy of the specification.

A. MUIRHEAD,
Managing Director.
91, Petty France, Westminster, S.W. 1.
5th December, 1928. 422

Severalls Mental Hospital, COLCHESTER.

WANTED, RESIDENT ASSISTANT ENGINEER and CLERK of WORKS. Must be capable man, steady and thoroughly reliable, fully qualified to take charge of power station, consisting of steam boilers, steam and oil engines, dynamos, switchboards, pumps, &c.

Candidates must be capable of supervising and undertaking repairs, &c., at such times as may be necessary. In addition, should have a knowledge of building construction and repairs. Only first-rate men will be considered.

Wages £5 per week. A cottage, together with firing and light, is provided within the Hospital grounds, for which a reasonable weekly charge is made.

The appointment is subject to the terms of the Asylums Officers' Superannuation Act, 1909.

Applications, stating age (which should not exceed 30 years), experience, &c., and accompanied by copies of three recent testimonials, to be made upon forms obtainable by enclosing stamped addressed envelope to the MEDICAL SUPERINTENDENT. 373

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SITUATIONS OPE

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED

WANTED, ASSISTANT to WORKS MANAGER for the Boiler Shop of a Marine Engine Works in the Clyde district. Should have a thorough knowledge of Construction and Cost of Boilers of Scotch and Water-tube Types, also of modern Boiler Shop Machines and Practice.

Applicants must state age, qualifications, experience, &c., also whether free for engagement.

Address, "CLYDE," Wm. Porteous and Co., Advertising Agents, Glasgow. P5260 A

WANTED, an ENERGETIC MAN, to Take Charge of Sales of a well-known make of Electric Arc Welding Plant and Welding Metals; must have had both Electrical and Metallurgical training.—Write, giving qualifications, experience, &c., to Z.X. 898, care Deacon's Advertising Agency, Fenchurch-avenue, London, E.C. 3. 233 A

WANTED by Well-known Firm Main Contractors, BOILER-HOUSE ENGINEER, with experience of Pulverised Fuel. Capable of putting new plants into operation and running trials. Able to control men.—Address, stating experience and salary expected, 389, The Engineer Office. 389 A

WANTED by an Established Firm of London Exporters, BUYER for Railway Department. Age 27-32. Experienced in Purchase of Light Railway Material, both British and Continental. Salary £300 p.a.—Reply, giving full particulars of experience, to Box E.5688, c/o Dawson's, 118, Cannon-street, E.C. 4. 421 A

WANTED, MANAGER for Works Manufacturing Twist Drills, Reamers, Taps, &c.; willing to go abroad and able to speak French; must be experienced and competent, possessing teonical knowledge of Machinery and Equipment and able to organise throughout.—Write, stating age, training, experience, salary required, and references available, to Box M. 312, Willings, 133, Moorgate, E.C. 2. P5264 A

WANTED, MAN, Capable of Taking Charge of Assembly of Mechanical Transport Units by means of conveyor principle, commencing output 100 per week. London district.—Address full particulars, 413, The Engineer Office. 413 A

AN ENGINEER REQUIRED for Irrigation Works in an Indian Native State; must be fully qualified and preference will be given to an applicant who has a knowledge of Hindustani. Appointment in first instance for three years. Applications to give full particulars of experience and salary required.—Address, Box 743, c.o. Browns, 30, Tothill-street, S.W. 1. 413 A

ASSISTANT ENGINEER WANTED for the Office of a Consulting Engineer for India. Must be of college education and sound practical works experience, able to design, estimate and supervise General Mechanical and Electrical Work. Must be A.M.I.C.E. and also preferably A.M.I.E.E., age 25 to 35 and unmarried. Salary £750 per annum and first-class passage to India with travelling expenses.—Apply in the first place to Post Box 2240 Calcutta, with detailed particulars of experience and education. 296 A

ASSISTANT ESTIMATOR (Experienced) WANTED, conversant with modern Electrical Engineering Practice, A.C. and D.C.—Address, giving full details, 386, The Engineer Office. 386 A

DIESEL ENGINE OPERATOR REQUIRED for services in Bolivia.

Man familiar with Willans-Robinson Engines preferred. Must be capable of making repairs.

Salary 275 dollars per month.

Address, giving full details of experience, &c., P5274, The Engineer Office. P5274 A

ENGINEER WANTED by Large Company in London for a period of eighteen months to two years. Must have experience on the steam side of Central Electricity Station, and be capable of compiling specifications for Boilers, Pipework, &c.—Write, stating age, qualifications and experience, and when free, "F. R.," c/o J. W. Vickers and Co., Ltd., 24, Austin Friars, E.C. 2. 367

PHOTO BLUE PRINTING.—MAN WANTED, to Take Charge of Manufacturing Engineers' Blue Printing Room and Drawing Files. Knowledge of Hall's Rotary Photo Copiers and modern Blue Printing, Photostat, and Reproduction Processes essential, together with experience of routine filing and card indexing.—Address, stating age, experience, and salary required, 377, The Engineer Office. 377 A

PROVINCIAL or LONDON AGENT REQUIRED, able to obtain orders for Machined Parts and Castings, &c. State trades connected with and full particulars.—Address, 395, The Engineer Office. 395 A

REQUIRED, an ELECTRICAL and MECHANICAL ENGINEER to assist Director at works; must have considerable technical and practical experience, tactful, first-class designer. Send full particulars and salary required.—Address, P5268, The Engineer Office. P5268 A

REQUIRED by Firm of Gearing Specialists Having Headquarters in London, ENGINEER-SALESMAN, to travel throughout the country. Technical training and previous travelling experience essential.—Write, giving full details as to age, experience, education, and salary required, to Box 87, c/o Mather and Crowther, Ltd., 10/13, New Bridge-street, London, E.C. 4. 412 A

REQUIRED for London Area, a First-class ENGINEER SALESMAN, with sound knowledge of all Steam and Oil Prime Movers, as well as Electric and Hydraulic Machinery. Must have had wide experience in calling on purchasers, following up tenders and be able to secure business. State age, qualifications, and salary.—Address, 397, The Engineer Office. 397 A

SALES ENGINEER WANTED by London Engineering Company specialising in Air Filtration, Dust Collection, Ventilation. Knowledge of subject essential. Send full particulars, technical and travelling experience, education, age, salary required.—Address, 379, The Engineer Office. 379 A

TOOL STEELS.—Efficient SALESMAN for London and Midlands WANTED by well-known Firm of Tool Steel Makers. Applicant with knowledge of metallurgy and modern heat treatment are invited to send full particulars of their qualifications.—Write, H. C., c/o J. W. Vickers and Co., Ltd., 24, Austin Friars, E.C. 2. 393 A

WANTED, First-class DRAUGHTSMAN DESIGNER in connection with Industrial Electric Heating and Cooking Appliances for large works in the Midlands. Electrical knowledge not essential.—Address, 388, The Engineer Office. 388 A

WANTED, High-class DRAUGHTSMAN, Used to Designing and Detailing Centrifugal Machines of all types. Only thoroughly experienced men need apply.—Address, 381, The Engineer Office. 381 A

WANTED, ROLL DESIGNER; Must Have Designing experience and be capable of undertaking standard and special sections. Prospects for right man.—Apply, stating age and experience, to FRODINGHAM IRON and STEEL CO., Ltd., Scunthorpe, Lincs. P5262 A

YARROW HOME and HOSPITAL
FOR CHILDREN
BROADSTAIRS.

For the Early & Preventive Treatment of Disease & Convalescence after Illness.

The Hospital is intended for the children of Members of the Institution of Civil Engineers, the children of architects, artists, authors, clergymen, members of the medical, legal, and other professions, members of scientific societies, officers of the Navy, Army, and Royal Air Force, officers of the Merchant Navy, schoolmasters and university professors.

Accommodation is provided for 50 Boys between the ages of 4 and 12 years, and 50 Girls between the ages of 4 and 14 years. In special cases the age limits may be raised to 14 for Boys, and 16 for Girls.

Fee 21/- per week, or as may be arranged, and travelling expenses.

Particulars can be obtained from the Secretary:—

116, Victoria Street, Westminster, LONDON, S. W. 1.

SITUATIONS OPEN (continued)

DRAUGHTSMAN, Accustomed to Preparation of Contract Drawings required for Water Scheme, including Pumping Station, in South Wales. Must be neat and quick. Preference given to one who can level and survey. Period about twelve months. State salary required.—Applications not later than December 10th, 1928, to 337, The Engineer Office. 337 A

DRAUGHTSMAN and ESTIMATOR REQUIRED for Heating and Ventilating, London. Must be fully experienced in all systems. Applications treated confidentially.—Address, stating age, experience, qualifications, and salary required, P5258, The Engineer Office. P5258 A

DRAUGHTSMAN (Engineer), Accustomed to Design and General Lay-out of Pumping Machinery and Auxiliary Plant, Estimating, &c.—Address, stating age, experience, and salary required, 9672, The Engineer Office. 9672 A

DRAUGHTSMAN for London REQUIRED, with experience Dust Collection and Ventilation. State experience, education, age, salary required.—Address, 380, The Engineer Office. 380 A

DRAUGHTSMAN REQUIRED by Midland Firm of Constructional Engineers. Must be fully qualified to design and estimate for Steel-framed Buildings, Lattice Girders, Towers, &c.—Address, with full particulars and salary required, 372, The Engineer Office. 372 A

DRAUGHTSMAN REQUIRED (Temporary, Six to nine months), having thorough experience in Water Supply Works, Levelling, Surveying, Reservoir Mains and Pumping Station Work. Three recent references. State salary required.—Application to WATER ENGINEER, 19, Cheap-street, Newbury, on or before the 17th inst. P5271 A

DRAUGHTSMEN (SENIOR) REQUIRED for Steam Turbine Details and Design.—Write, giving particulars of experience, salary, age, and date free, to CHIEF DRAUGHTSMAN, English Electric Co., Ltd., Rugby. 410 A

DRAUGHTSMEN WANTED, Accustomed to Mechanical Design, A.C. and D.C. Machines. State age, experience, and salary required.—Address, 386, The Engineer Office. 386 A

DRAUGHTSMAN WANTED (for Approx. Six months), experienced in Factory Lay-out for Repetition Work in Light Steel Sections.—HENRY HOPE and SONS, Ltd., Halford Works, Smethwick. 400 A

DRAUGHTSMAN WANTED, Thoroughly Experienced in General Constructional Steel Work; no others need apply.—State age, salary and particulars of experience to THOMAS PIGGOTT and CO., Ltd., Atlas Works, Spring Hill, Birmingham. P5261 A

DRAUGHTSMAN, with First-class Experience of Steam Turbine design and detail work, for works in Midlands. State age, salary, experience, and when able to commence.—Address, 274, The Engineer Office. 274 A

ENGINEER and ESTIMATING DRAUGHTSMAN with intimate knowledge of Chemical Process Plant, including Evaporating and Distilling Equipment, REQUIRED by Engineers, Glasgow. State full particulars and experience.—Address, 312, The Engineer Office. 312 A

ENGINEERING FIRMS in Lancashire, Making and Installing Fans and accessories, REQUIRE thoroughly competent CHIEF DRAUGHTSMAN. State age, experience and salary required.—Address, 360, The Engineer Office. 360 A

EXPERIENCED DRAUGHTSMEN WANTED in Midlands for Heavy Oil Engine Work. State age, experience, salary required, and when free.—Address, 409, The Engineer Office. 409 A

JUNIOR DRAUGHTSMAN REQUIRED in London district; must have had previous experience in the preparation of workshop details for Structural Steel Work.—Address, stating age, salary expected, and giving outline of qualifications, 396, The Engineer Office. 396 A

JUNIOR DRAUGHTSMAN WANTED, Accustomed to detail work. Quick and accurate. State qualifications, experience, age, and salary required.—Address, 399, The Engineer Office. 399 A

REQUIRED AT ONCE, SENIOR CRANE DRAUGHTSMAN, Birmingham district.—Address, 359, The Engineer Office. 359 A

REQUIRED, ENGINEERING DRAUGHTSMAN, used to Electrical, Steam and Hydraulic Plant Lay-outs. Must be rapid and accurate calculator. Progressive position to right man. State age, training past experience, and salary required.—Address, 391, The Engineer Office. 391 A

REQUIRED, First-class JIG and TOOL DRAUGHTSMAN; preference given to man with experience of designing rolls and dies for producing sections of light-gauge strip. State age, experience, salary, when at liberty, &c., to Messrs. THE BLACKBURN AEROPLANE and MOTOR CO., Ltd., Brough, E. Yorks. 398 A

SENIOR DRAUGHTSMAN and DESIGNER WANTED, with good experience in the design of the latest type Commercial Vehicles.—Address, giving full particulars of experience, age, and salary required, 376, The Engineer Office. 376 A

SENIOR DRAUGHTSMAN, Instrument Design Experience preferable. Good prospects. London district.—Box 4358, Woodwright Service, Ltd., 150, New Bond-street, W. 1. 375 A

STEAM TURBINE DESIGNER REQUIRED, with recent experience of calculations and design of modern Steam Turbines, small and medium units.—Box 39, Kennington Advertising Service, 4, Regent-street, London, S.W. 1. 390 A

SITUATIONS OPEN (continued)

STRUCTURAL DESIGNING DRAUGHTSMAN REQUIRED. Must be capable of designing all classes of Structural Steel Work.—State age, experience, and salary required to BOULTON and PAUL, Ltd., Norwich. 382 A

STRUCTURAL DRAUGHTSMAN and ESTIMATOR REQUIRED as Technical Assistant in Tea Garden Engineering Department of firm in Calcutta. Age not over 30, Scotsman, single. First agreement 4 years.—Address, giving full details of experience, 408, The Engineer Office. 408 A

MAN REQUIRED by West London Firm with thorough knowledge of Press Tool Work, to act as Working Foreman. Permanent job for good man. State salary required.—J. PAYEN, Ltd., Church Wharf, Chiswick, W. 4. P5263 A

SITUATIONS WANTED

ENGINEER, Age 33, First-class B.O.T. Ordinary certificate, first-class B.O.T. motor certificate, 5 years' experience with Diesel machinery, two years as chief engineer, SEEKS POSITION ASHORE; excellent refs.—Address, P5269, The Engineer Office. P5269 B

ENGINEER DESIRES POSITION, Aged 43 Years, 7 years assistant works manager shipbuilding and repairing, experienced steam, internal combustion, electric and hydraulic, also factory and works maintenance. Excellent references.—Address, P5253, The Engineer Office. P5253 B

ENGINEER, 20 Years' Experience, Steam, Oil, Gas engines, boilers, pumps, compressors, crushers, dryers, mills, roasters, machine, carpenter, boiler shop work, concrete brickwork; age 43. Anywhere, abroad.—Address, 383, The Engineer Office. 383 B

ENGINEER, with Considerable Technical, Practical and service experience, DESIRES APPOINTMENT, Sales or Technical Traveller. First-class designer, with research and experimental work in mechanical electrical apparatus, also traction.—Address, P5267, The Engineer Office. P5267 B

EXPERIENCED MODERN WORKS MANAGER AT LIBERTY; accustomed full control and responsibility for production light and medium engineering products.—H. W., 40, Lebanon-road, Croydon. P5227 B

GENTLEMAN (38), Shortly Disengaged, DESIRES RESPONSIBLE POSITION; many years' commercial experience, engineers, iron, steel merchants, buying, selling staff management. Interview solicited.—Address, P5252, The Engineer Office. P5252 B

MECHANICAL ENGINEER, with Wide General engineering experience as foreman, cost clerk and manager, SEEKS RESPONSIBLE POST in Works or Office. Moderate salary.—Address, P5270, The Engineer Office. P5270 B

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For continuation of Small Advertisements see page 4.

A Seven-Day Journal

Steel Sleepers on British Railways.

FOR some years past the Southern Railway has been testing the use of steel sleepers on a portion of its Portsmouth line between Guildford and Worplesdon over which there pass trains composed of modern rolling stock and drawn by engines of the "King Arthur" class. The results of this test have been technically satisfactory, and as an outcome the directors of the company have approved of a substantial order being placed for steel sleepers. The order covers the supply of 70,000 steel sleepers, complete with chairs and equivalent to 5000 tons of steel. It has been placed with the United Steel Companies, Ltd., and, it is understood, will be executed at that federation's Workington mills. Its value is about £52,000. The sleepers included in this order will be used during the next two years for the equipment of about 35 miles of track. The company has been led to favour the adoption of steel sleepers because of the rising cost of wooden sleepers, because it anticipates that they will have a longer life, and because by adopting them it will help a British industry instead of spending money abroad. The other British railway companies are also at present testing the merits of steel sleepers. For some time past the Great Western Railway has been experimenting with them, and it is now reported that it is about to use them on another section of line extending to about a mile in length near the London area. It is understood that the order for these sleepers has been placed with Guest, Keen and Nettlefolds, Ltd., of Smethwick, and that that firm is also engaged in making steel sleepers for the London, Midland and Scottish Railway. The annual consumption of sleepers in this country is said to be about 4,000,000. If, therefore, only 10 per cent. of the new sleepers required were to be made of steel, the orders placed with the steel industry for their supply would represent about 30,000 tons of sleepers, valued at over a quarter of a million sterling.

The Supermarine Aviation Works.

ACCORDING to an official announcement, Vickers (Aviation), Ltd., has acquired all the share capital of the Supermarine Aviation Works, Ltd. Vickers (Aviation), Ltd., is a company owned entirely by Vickers, Ltd., and was not included in the undertakings brought under the recent Vickers-Armstrong amalgamation. It carries on the manufacture of aeroplanes and amphibian flying boats at its works at Brooklands. The works of Supermarine Aviation Works, Ltd., are at Southampton and Woolston. The company was formed in 1912 by Mr. Noel Pemberton Billing, who from the outset specialised in the construction of flying boats. During the war Mr. Billing ceased his connection with the company. It has continued to specialise in the construction of flying boats and seaplanes, its best known productions of recent times being the Supermarine-Napier "S 5" seaplane, which won last year's Schneider Cup Race, and the twin-engined Southampton flying boats, four of which are, and have been since the beginning of this year, engaged on an extensive world cruise. It is intimated that the Supermarine Aviation Works, Ltd., will continue to exist as a separate company, and that its present *personnel* will continue in office. The company's managing director is Squadron-Commander James Bird, and its chief designer is Mr. R. J. Mitchell.

London Rates for Electricity.

A SPECIAL committee has been authorised by the London and Home Counties Joint Electricity Authority, to undertake a review of the charges and conditions imposed by electricity undertakers in their districts, and the Authority is now in communication with local authorities and electricity companies concerned. The inquiry was proposed by the Electricity Commissioners, who suggested that any steps which might be taken, as a result of the review, to make the bases of the charges more uniform in relation to supplies of electricity, the provision of electricity services, the hire of meters, &c., would be of advantage to the public, and would tend to promote the development of the supply in the district as a whole. It was proposed that the review should be directed more particularly to :—(*a*) A comparison of the leases and amounts of the various charges and tariffs adopted by authorised undertakers in the district for supplies of electricity for lighting, for general domestic purposes, and for power purposes, respectively; (*b*) the extent to which the charges and tariffs in the case of individual undertakers are due to particular circumstances of the undertakings concerned; (*c*) the steps which could be taken to secure greater uniformity of charges and tariffs throughout the district; (*d*) the form of multi-part tariff or tariffs best suited to the requirements of the district, and the steps necessary to bring about the general adoption of such a tariff or tariffs within the district; (*e*) the facilities afforded by authorised undertakings in the district in regard to the hiring of apparatus, &c., hire purchase, and assisted wiring in order to encourage the domestic demand and so reduce prices; and (*f*) the effect upon charges for electricity of the sliding scales of price and dividend prescribed by the London Electricity Acts, 1925, and by other special or Provisional Orders in force in the district. The report of a special committee appointed to consider the proposed investigation quotes figures showing variations in the flat rate or commencing charge per unit for lighting on July 1st, 1928. The highest price was 10d. per unit charged by four companies and 9d. per unit by ten companies and one local authority. The lowest figures were 3d. per unit charged by one local authority and 3½d. per unit charged by one company and five local authorities.

The U.S. Government's Merchant Fleet.

THE United States Shipping Board, in a statement submitted to Congress on Monday of this week, reported that during the 1928 fiscal year the operation of the merchant ships owned by the U.S. Government resulted in a loss of over £3,250,000. This figure is £70,000 in excess of the loss recorded last year, and brings the total deficit for the past five years up to nearly £25,000,000. During the past year sales of the Government vessels have reduced their number from 273 to 230. The Board attributes the increased loss incurred to a lower demand for tonnage, and states that the greatest handicap to the profitable operation of the Government's merchant fleet is the lack of vessels of suitable speed, type and equipment to compete successfully with privately owned foreign vessels operating on the same routes. For every ocean-going vessel being built in the United States, the Board remarks, Great Britain is building fifty, Germany ten, France and Italy five each, and Japan four. In the matter of new construction, the United States is therefore being rapidly outdistanced. Government loans have been granted to the extent of over £3,000,000 to help seven companies to build fourteen new ships, but, in the opinion of the Board, the United States mercantile marine will not give its best service to the public until a variety of conditions have been fulfilled. Among these conditions are the adoption of the Hague rules and the enactment of a Load-line Bill, the codification of the Navigation laws, the exemption from tax of American vessels operating in foreign service, and the creation of an insurance system that will place American ships on a footing of equality with foreign ships.

The Stratford Works of the L.N.E.R.

PRESIDING at a meeting last week of the Great Eastern Mechanics' Institution, held at the Town Hall, Stratford, E., Mr. William Whitelaw, Chairman of the London and North-Eastern Railway Company, took advantage of the occasion to set at rest certain rumours regarding the company's intention to abolish the Stratford Works. It was said, he remarked, that the Stratford Works had been allowed to deteriorate a little in efficiency and in equipment, and that the development of railway amalgamation might put an end to much of the work conducted at them. He assured his hearers that the company could not get on without the Stratford Works, and that instead of being abolished they were to be re-equipped. We understand that it is the company's intention to increase the facilities available at the Stratford Works for the repair of carriages, and that the directors have already authorised a scheme of alterations. More than 5000 carriages, saloons and vans belonging to the Great Eastern section, representing about a quarter of the total coaching stock owned by the company, are centred on the Stratford Works. It is the intention, we gather, to enlarge the carriage lifting shop, to make alterations to its permanent way, and to provide it with new machinery. The carriage body repair shop and the carpenters' and cabinet makers' shops are to be altered structurally, and are to receive new equipment. A new accumulator shop is to be erected and traversers, cranes, &c., are to be provided.

Railways and Road Transport.

THE railway companies are losing little time in taking advantage of their new road transport powers. It is announced that the London, Midland and Scottish Railway and the London and North-Eastern Railway have made arrangements with the Corporation of Sheffield for the adoption of a comprehensive scheme for the co-ordination of railway and road transport in the Sheffield area. At present the Corporation operates omnibus routes extending as far as Barnsley, Huddersfield, Buxton, Bakewell, Chesterfield, and other places. Under the scheme arranged these routes will be taken over and operated by the two railway companies. Other Corporation omnibus routes extending to shorter distances from the city will be owned jointly by the Corporation and the railways, and will be operated under the auspices of a joint committee. The local routes within the city will remain as at present under the Corporation's control. Another instance of the railway companies' determination to make use of their new road powers is to be found in the fact that on Monday of next week, December 10th, the London, Midland and Scottish Railway will open an omnibus service between the towns of Rochdale and Halifax. Over this route of 18 miles twelve trips will be made daily in each direction, with an hourly service on Saturdays and Sundays. The service at present operated by the Rochdale Corporation will cease to run. The omnibuses to be used by the railway company are single-deck vehicles, the bodies of which have been constructed in the company's own workshops. The company's service will operate between the railway stations in the two towns, but it will also be available to passengers who desire to proceed to intermediate points.

An Interesting Oil Tanker.

THERE was launched from the Scotstoun Yard of the Blythswood Shipbuilding and Engineering Company, Ltd., on Friday last, November 30th, the oil tanker "Irania." This vessel is interesting in view of the fact that she is propelled by the first set of Richardsons-Westgarth double-acting two-stroke marine oil engines to be used for sea service. The new tanker, which is now being fitted out at Rothesay Dock, has an overall length of 300ft., with a beam of 44ft. and a depth moulded of 20ft. She will be employed in the service of the Iranian Tanker Company, Ltd., of London. In accordance with the usual practice, the machinery is placed right aft, and the accommodation for the officers, engineers and crew is also arranged at this part of the ship, the navigating bridge being placed amidships. The two cargo pumps, each of which has a designed capacity of 160 tons per hour, are steam driven, and are housed in a special pump room amidships. Steam for working these pumps and the engine-room auxiliaries is provided by two 100 lb. pressure Cochran type boilers. The engines, which have been constructed by Richardsons, Westgarth and Co., Ltd., at West Hartlepool, are of the double-acting two-stroke type, and they operate on a dual combustion cycle with airless injectors. There are three cylinders, each with a bore of 21½in. and a stroke of 38in., with a total designed output of about 1100 S.H.P. at 85 revolutions per minute. The vessel has been built to Lloyd's highest class, under the supervision of William Esplen, Son and Swainson, Ltd., of London.

Wired Wireless.

IT is predicted that within the next twenty years most of the broadcasting in the United States will be carried on over household electric light and power wires, and it is hoped that in this way many broadcasting difficulties will be overcome. The North American Company, the largest supplier of electric light and power in the United States, has granted the Kolster Radio Corporation a title to 600 of its patents in return for exclusive licences in the field of wired wireless, to one of its subsidiary companies, known as Wired Radio Inc. These patents include the fundamental patent for chain broadcasting as well as patents for television and talking motion pictures. The Kolster Radio Corporation has also received from the North American Company the contract to manufacture for Wired Radio Inc. not less than one-third of the apparatus, the value of this business being estimated at about £7,200,000 per annum.

The Solent Tunnel Proposal.

ON numerous occasions in the past it has been proposed to facilitate transit between the mainland and the Isle of Wight by the construction of a tunnel beneath the Solent. At present the passage from Portsmouth to Ryde occupies about three-quarters of an hour from pier to pier, and the journey is mostly in sheltered waters. The suggestion for the construction of a railway tunnel that would enable the very worst of sailors to reach the island without discomfort has recently been revived, and the Isle of Wight County Council has been in communication with the Ministry of Transport in connection with the subject. The Ministry has, however, taken up an attitude on the point which can only be described as discouraging. It finds no reason to anticipate such a large increase in the Island's traffic requirements as would justify the great expense that would be involved in constructing the tunnel. It is unable, therefore, it adds, to entertain any application for financial assistance towards carrying out the proposal. In view of this statement of the Ministry's attitude towards the scheme the Isle of Wight County Council on Wednesday of this week decided to take no farther action in the matter for the present.

The Tilbury Section of the L.M.S.R.

ONE of the conditions laid down in the Act of 1912 whereby the Midland Railway acquired what is now the Tilbury section of the London, Midland and Scottish Railway was that the railway between Fenchurch-street and Southend should be converted to electric traction. An interesting sequel to that Act appears to be foreshadowed in the application for parliamentary powers in the 1929 session. The proposals seem to suggest that the Southend trains will be based on Broad-street instead of Fenchurch-street. The journey would then be wholly over the L.M.S. Company's own metals through Dalston, Homerton, Old Ford, and Bromley, instead of over the London and North-Eastern between Gas Factory Junction and Fenchurch-street. The Bill also seeks to repeal the powers for electrification.

The Turbines at the Klingenberg Power Station.

No. I.

THE great Klingenberg power station, recently put into commission by the City of Berlin Electricity Company, is noteworthy, not only for its size, but as representing the very latest continental practice in super-stations. Situated at Rummelsburg, on the bank of the Spree, a few miles from Berlin, it was originally called the Rummelsburg station, but was given its present name as a memorial to Dr. G. Klingenberg, the well-known director of the Allgemeine Elektricitäts Gesellschaft, who was responsible for its design. The necessity for a new station was acutely felt in 1924, when the peak load rose to 208,500 kW, as compared with 142,000 kW the year before; this great increase in the demand for electric energy being largely due to the better industrial conditions which followed the stabilisation of the mark. To deal with this situation, a site of about 49 acres was obtained at Rummelsburg, with the intention to construct a super-station to have an eventual maximum capacity of 540,000 kW. The plans provided for the station to be built in two parts, half the ultimate capacity being provided immediately. So energetically was the work proceeded with that, although the first sod on the site was only cut on September 15th, 1925, on July 30th, 1927, the first part of the station was completed and 270,000 kW of generating machinery, with the necessary switchgear, transformers, &c., was ready for service.

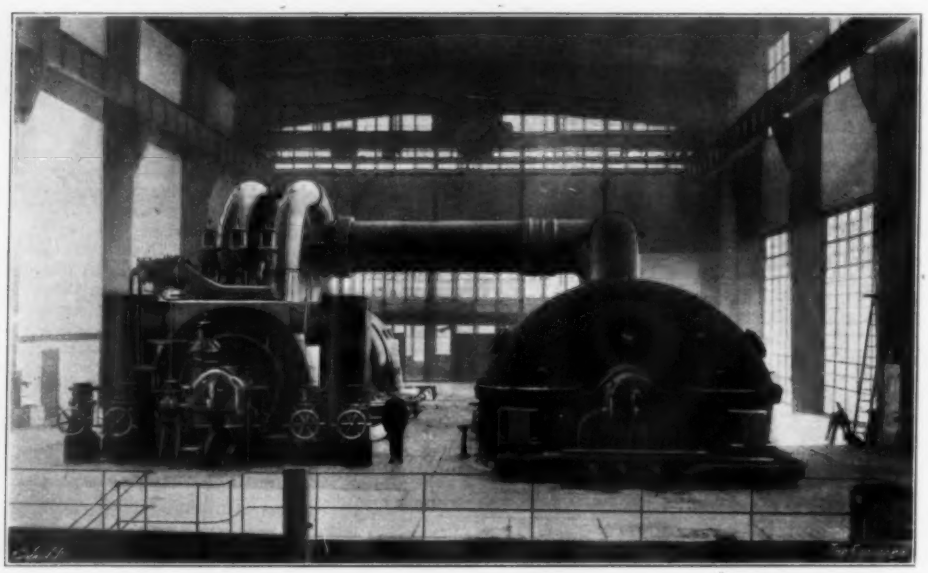


FIG. 1—80,000 kW TURBO-GENERATOR. STEAM END

Although the object of this article is to give a description of the turbines, a few words concerning the design of the station generally will not be out of place. The main engine-room contains three A.E.G. turbo-generators of a maximum continuous rated capacity of 80,000 kW each, placed end to end and in line with each other. Situated centrally with, and at right angles to, the main engine-room, is a second engine-room containing three house turbines rated at 10,000 kW capacity each, and the boiler feed and other pumps. On either side of this second engine-room is a boiler-house, containing eight boilers,

TABLE I.—*Dimensions of Principal Buildings.*

Building.	Length, feet.	Breadth, feet.	Height to eaves, feet.
Main engine-room ..	478·3	84·1	82·7
Boiler-house, each ..	243·8	135·6	100·1
House turbine-room ..	243·8	82·9	68·4
Offices	426·5	72·2	57·4
30,000-volt switch-house	459·3	59·1	63·0
Mill-house	390·4	82·0	125·3
Administrative block ..	88·6	62·3	139·4

the central aisle of each house running at right angles to the main engine-room. The boilers, which generate steam at 35 atmospheres, or 498 lb. absolute, and 410 deg. Cent., are of different types and makes, the heating surface of each being about 19,375 square feet, and the maximum rated output about 80 tons of steam per hour. They are all fired by pulverised coal, the coal being prepared in a mill-house some little distance away. Each pair of boilers is served by a steel chimney, 230ft. high. The mill-house contains four sets of machinery, each consisting of a steam-heated dryer with a capacity of 24 tons per hour, and two pendulum grinders of an equal combined capacity. Four coal dust pumps, rated at 50 tons per hour each, deliver the ground coal to the bunkers of the individual boilers. There is a raw coal storage capacity for 220,000 tons, the coal pile being commanded by two transporters, each capable of handling 140 tons per hour. The main part of the power generated by the station is stepped up to 30,000 volts for transmission to the sub-stations. The apparatus for the control of the high-tension circuits is housed in a special building, separated from the engine-room by a wide roadway. Table I. gives the overall dimensions of some of the principal buildings of the Klingenberg station.

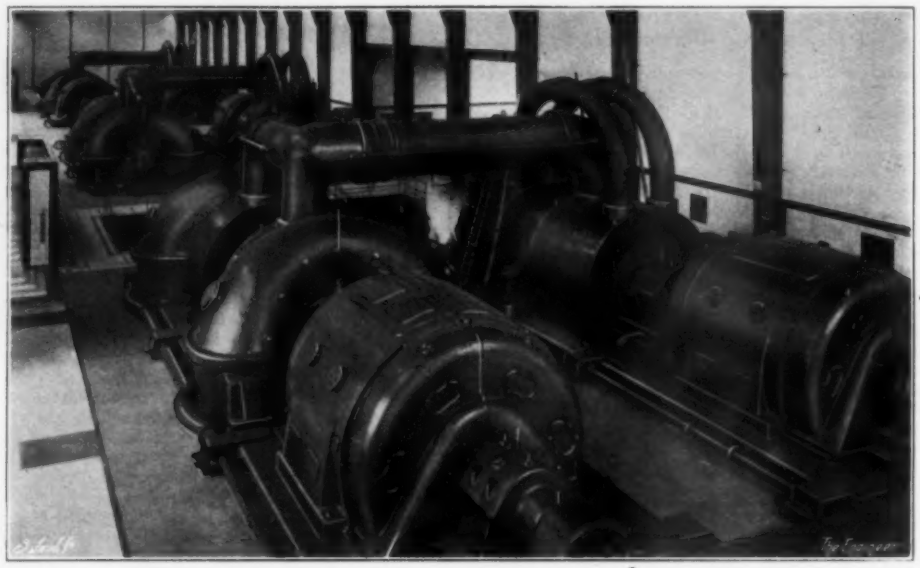


FIG. 2—THREE 80,000 kW TURBO-GENERATORS

THE MAIN TURBINES.

As we have mentioned above, the main units were supplied by the Allgemeine Electricitäts Gesellschaft. Each consists of a turbo-generator of a maximum rated capacity of 80,000 kilowatts, with which is associated a house turbine of 10,000 kilowatts capacity. The main units are thus the largest prime movers running in Europe at the present time. Their general appearance will be gathered from Figs. 1 and 2, the former illustration showing a single unit viewed from the steam end, and the latter the arrangement of the three units in the engine-room. Each unit comprises a pair of similar alternators of 44,000 kVA rating, driven at 1500 revolutions per minute by a four-cylinder turbine arranged on two shafts. One shaft carries the high-pressure and the intermediate-pressure cylinders of the turbine, and the other the two low-pressure cylinders, through which the steam passes in parallel. The total length of the high-pressure side of the unit measured to the end of the outboard bearing of the exciter is 72·47ft., the length of the low-pressure side, similarly measured, is 76·3ft., and the distance between the centres of the two shafts 28·87ft. The shafts are 4·25ft. above floor level and the bottom of the basement 25·76ft. below floor level. These dimensions alone are sufficient to indicate the enormous size of the machines. Each low-pressure turbine exhausts into a horizontal condenser placed transversely beneath it, the two condensers being coupled together by a large pipe, so that in emergency the whole of the exhaust steam can be dealt with by a single condenser. The general arrangement of a complete unit is fully illustrated in Figs. 3 to 6. From these drawings it will be seen that the steam connections between the various cylinders are overhead, two pipes side by side, with sufficient elasticity to allow for expansion,

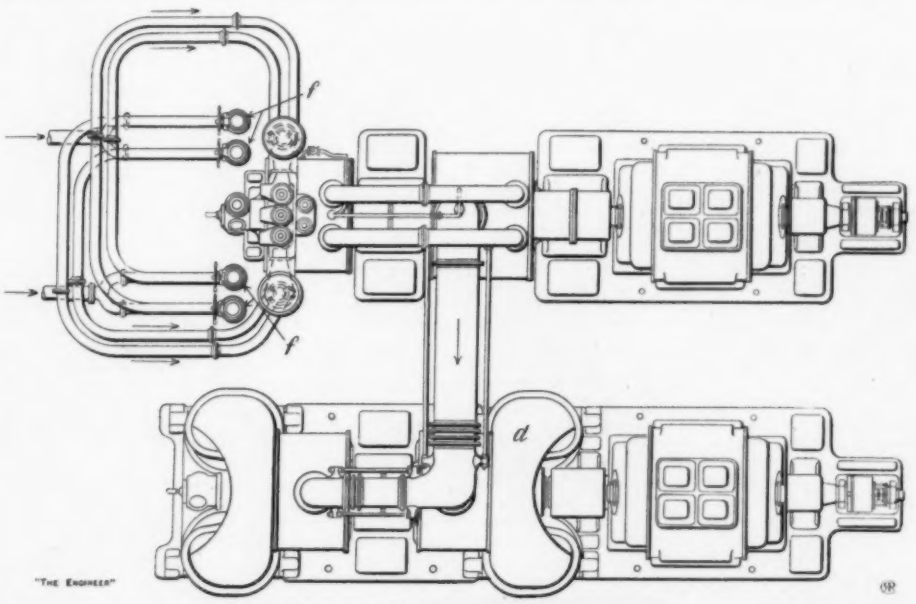


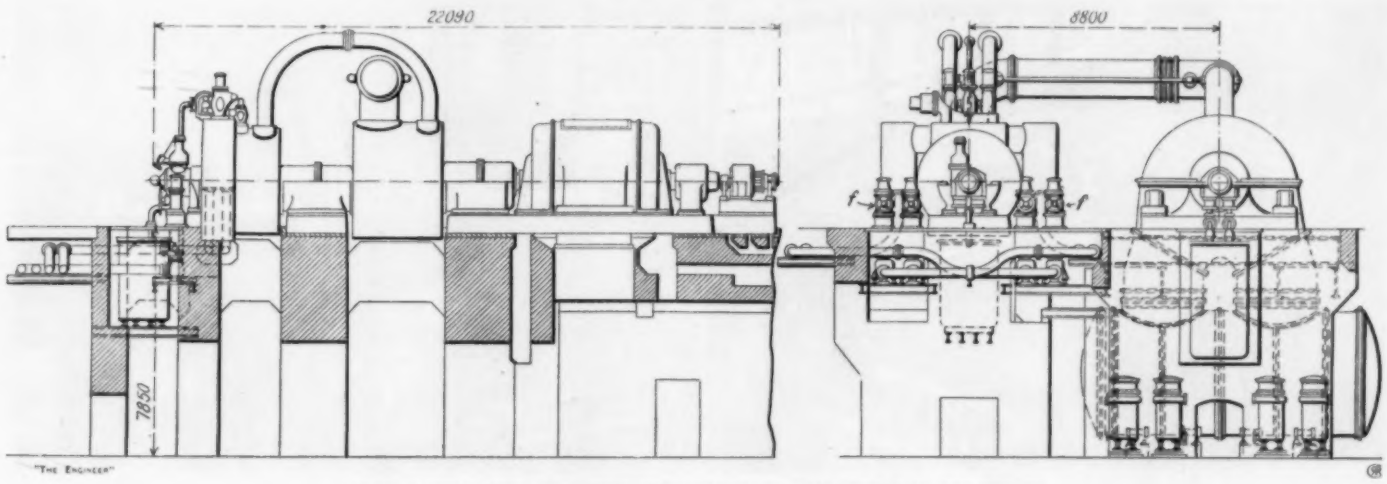
FIG. 3—PLAN OF 80,000 kW TURBO-GENERATOR

leading the steam from the high-pressure to the intermediate-pressure cylinder, and a single pipe with expansion joint taking the steam from the latter to the low-pressure side of the unit. The two inlets to

is secured and all strains on the turbine casing avoided.

The construction of the turbine is well shown by the two sections in to-day's Supplement, the upper being a longitudinal section through the high-pressure

remain substantially constant. The diaphragms are of cast steel, fixed to the inner cylinders and divided on the horizontal diameter, so that the rotor can be lifted clear when the turbine is opened. The



FIGS. 4 AND 5—END AND SIDE ELEVATIONS OF H.P. AND L.P. CYLINDERS

each of the condensers are provided with expansion joints, the condensers themselves being solidly seated

TABLE II.—*Particulars of Klingenberg Main Units.*

Maximum continuous rated output	80,000 kW
Revs. per minute, each shaft	1500 r.p.m.
Voltage at generator terminals	6600 volts
Frequency	50 cycles
Steam Conditions.	
Absolute pressure at stop valve	33·5 atm. (475 lb.)
Steam temperature at stop valve	400° C. (752° F.)
Absolute pressure—	
At inlet of I.P. cylinder	14·0 atm. (199 lb.)
At inlet of L.P. cylinders	2·3 atm. (32·7 lb.)
At inlet of condensers	96% vac. (1·2in. Hg.)
H.P. Cylinder.	
Number of stages:	1 two-row velocity compounded wheel, 14 simple impulse wheels
Mean diameter of all blading	1000 mm. (3·28ft.)
First row of simple impulse blading—	
Length	77 mm. (3·03in.)
Width	20 mm. (0·79in.)
Last row of simple impulse blading—	
Length	126 mm. (4·96in.)
Width	20 mm. (0·79in.)
Material of blading and shrouding:	Stainless steel
I.P. Cylinder.	
Number of stages	16 simple impulse wheels
Mean diameter of all blading	1400 mm. (4·59ft.)
First row of blading—	
Length	69 mm. (2·72in.)
Width	20 mm. (0·79in.)
Last row of blading—	
Length	277 mm. (10·91in.)
Width	30 mm. (1·18in.)
Material of blading:	First stage stainless steel, remaining stages low-nickel steel
Each L.P. Cylinder.	
Number of stages	24 reaction
Mean diameter—	
First row	1360 mm. (4·46ft.)
Last row	2890 mm. (9·48ft.)
First row blading—	
Length	171 mm. (6·73in.)
Width	26 mm. (1·02in.)
Last row blading—	
Length	610 mm. (24·01in.)
Width	Taper, 70 mm. to 30 mm. (2·75in. to 1·18in.)
Material of blading:	First row low-nickel steel, last rows stainless steel
Material of shrouding:	Brass, Monel metal and stainless steel

on their foundations. Live steam is brought to the turbine by two independent pipes, each of which is

and intermediate-pressure cylinders, and the latter a similar section through the pair of low-pressure cylinders. The leading features of the design are summarised for convenience in Table II.

As will be noticed from the drawings, the steam flows in opposite directions through the high-pressure and intermediate-pressure cylinders, and also in opposite directions through the two low-pressure cylinders. An axial balance is thus secured on both sides of the turbines, so that the thrust blocks have hardly any duty to perform beyond locating the shafts

nozzle groups are built up of accurately formed pieces and held mechanically on the diaphragms. All the wheels of the high-pressure rotor are turned solid with the shaft from a single forging, with the exception of the single velocity compounded wheel, on which the steam first acts. This wheel is fixed to the shaft by a conical bush in accordance with the usual A.E.G. practice in such cases. The formation of the fourteen simple impulse wheels from the solid, permits the individual wheels to be much closer together than if they were mounted separately, and thus results in

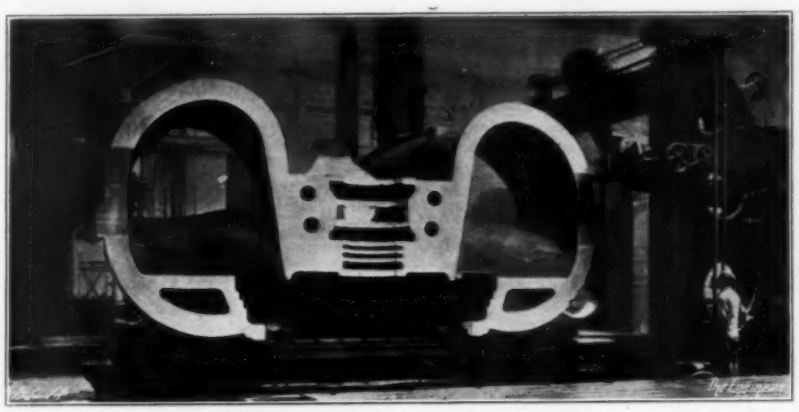


FIG. 7—LOWER HALF OF EXHAUST CASING

in their correct axial positions. The casing of the high-pressure turbine is of cast steel, divided only on the horizontal diameter. Within it are fixed two inner cylinders, also of cast steel, which hold the diaphragms. Steam can circulate between the casing and the inner cylinders, so that they are rapidly and evenly heated when the turbine is started. This fact, combined with their simplicity of form, safeguards the machine from the troubles which might otherwise arise, owing to the distortion of the casing

a very short and stiff rotor. It may be mentioned that this, like all the other turbine rotors, runs in its own pair of bearings, and each is designed for a critical speed well above the running speed.

The casing of the intermediate cylinder, besides being split horizontally, has a circumferential joint

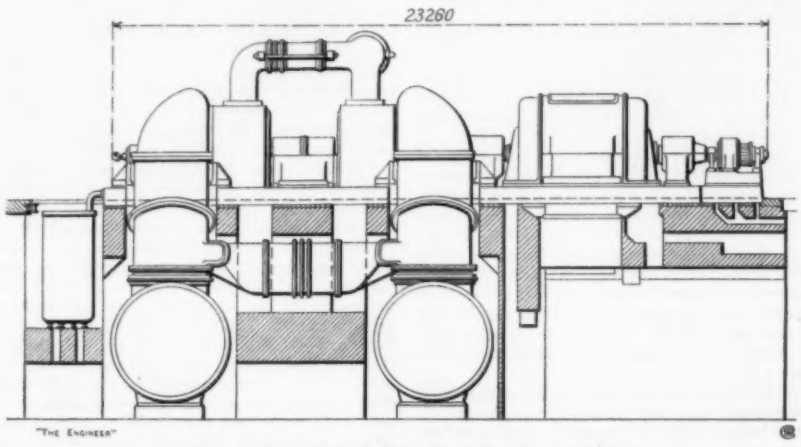


FIG. 6—SIDE ELEVATION OF L.P. CYLINDERS

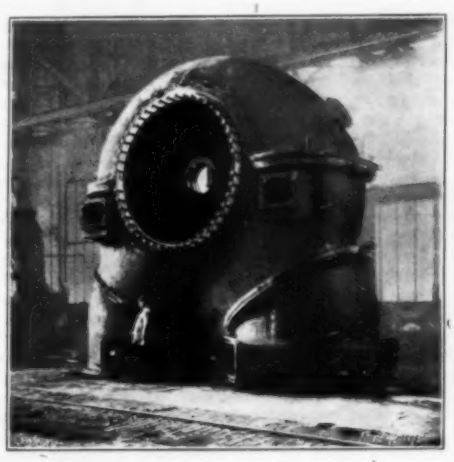


FIG. 8—EXHAUST CASING

branched so as to serve a pair of stop valves. From the pair of stop valves at each side of the high-pressure cylinder, curved pipes are led to the other side of the machine, so that very complete flexibility

with varying temperature. Moreover, the equalisation of temperature between the fixed and moving parts of the turbine ensures a practical equality in their expansion when heated, so that blade clearances

about half way along its length. On the high-pressure side of this joint the casing is of cast steel, and on the low-pressure side, where the pressure and temperature of the steam are both quite moderate, the material is of cast iron. The diaphragms are also of cast iron, fastened directly to the interior of the casing and containing cast-in nozzle plates in accordance with

STEAM TURBINES FOR THE KLINGENBERG POWER STATION

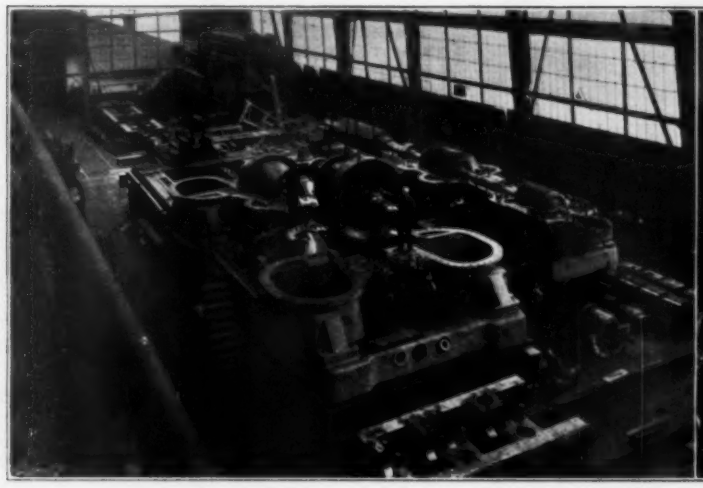


FIG. 9—80,000 kW TURBINE BEING ERECTED

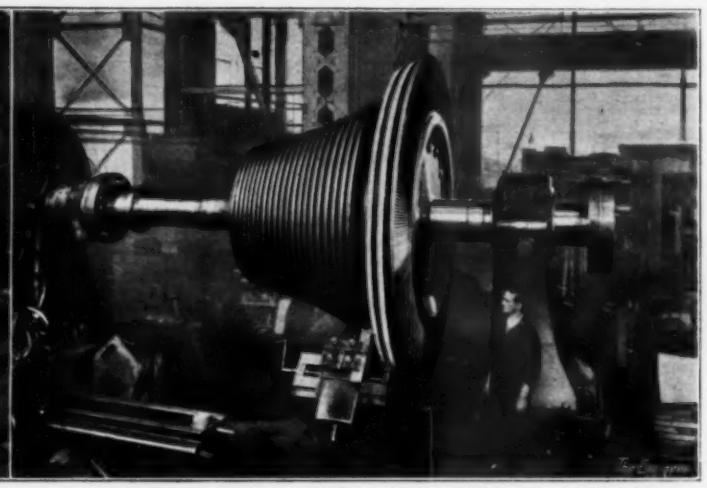


FIG. 10—LOW-PRESSURE ROTOR

usual practice. The wheels of the rotor are mounted individually on the shaft, instead of being formed solid with it, as in the high-pressure cylinder. The low-pressure casings are of cast iron, but are made with a circumferential joint, in view of the magnitude of the castings involved. Great car was taken in the design of the exhaust branches, in order that the minimum of resistance to the flow of the steam to the condenser might be secured, and the full value of the vacuum therefore realised. The lower half of one of the exhaust ends, as it appeared on the planing machine, is shown in Fig. 7. As will be observed, a guide plate formed solid with the casting, serves to direct the steam flow on each side to the condenser, and acts at the same time as a stiffening rib. The casting, which weighs about 60 tons, and measures over 21ft. across the flanges, is further stiffened by bolts which traverse it, as the average thickness of the metal in the walls is only about 2·4in. The same casting, with a man standing on it, is prominent in the foreground of Fig. 9, which shows the whole machine under erection at the works. It is to be seen again in Fig. 8, forming part of the complete exhaust end of one of the low-pressure turbines. The appearance of one of the bladed low-pressure rotors, during the operation of turning the shrouding, is shown in Fig. 10, its size being evident by comparison with that of the man alongside.

(To be continued.)

The Outlook from a Locomotive.

By C. F. DENDY MARSHALL, M.A., M. Inst. Loco. E.

IT is a very remarkable thing that the drivers of railway engines should always have been at so great a disadvantage as they have, in respect of ability to see where they are going.

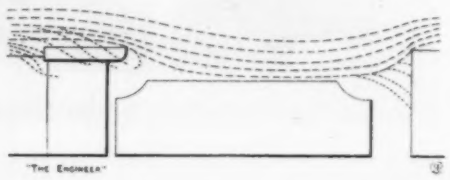
For many years they were given no protection whatever, and had to face a terrific gale blowing off the fire-box, laden always with red-hot cinders, and sometimes with rain, hail, or snow. Then came weather boards, followed by cabs; and in the days of low-pitched boilers they might have been given a splendid view, at all events when it was not raining. But the windows provided were never as large as they might have been, and were sometimes too high up for a short man to see through at all; so that the unfortunate drivers had to put their heads out into the hurricane, in order to catch a glimpse of the signals.

Nowadays, owing to the exceedingly narrow margin between the area of the fire-box and that of the loading gauge, there is very little room for windows, although it must be conceded that much more care is taken with their design, and the long slips of glass down the sides of the fire-box give a far better view than some of the old-fashioned tiny round windows which only a tall man could see through without craning his neck. Occasionally, however, even well-arranged windows are partly obstructed by a lubricator, the bend of a pipe, or a handle. When a tank engine is running bunker first, all should be plain sailing. But one not infrequently sees them going along with coal piled right up to the top of the cab, completely blocking the view, the windows being actually protected by iron bars for this very purpose. In the event of an accident occurring in such circumstances as these, through a signal being passed at danger, it is probable that extremely unpleasant comments would be made on the practice, if it came to light in the course of the inquiry.

In the case of engines running in the normal direction, now that the chimneys have shrunk to little more than holes in the top of the smoke-box, there is the additional disadvantage that the steam persistently blows down in front of the windows in an impenetrable fog. Attempts which have been made to deal with this difficulty, such as wings in the chimney, and upright plates at the sides of the smoke-box, have the effect of increasing the resistance; as model tests in an air tunnel would very soon demonstrate. Moreover, they are only tinkering attempts at a cure, whereas what should be aimed at is the prevention, by removing the cause. Before that can be done, it is obviously necessary to know why the steam curves downwards over the fire-box, when its natural tendency should be to rise, until it is cooled down to the temperature of the air. The cause is clearly the hollow space over the tender. The air pours down in a spate over the rear edge of the roof of the cab. This body of air is not cleanly cut off from its surroundings, but is enveloped by induced currents in more or less the same direction. And when, as is the case more often than not, the roof of the cab projects a couple of inches or so in front, it catches a certain amount of air and turns it downwards, which would otherwise escape over the top with the main body.

The state of affairs is illustrated roughly by the appended sketch, the induced currents of which I have spoken being indicated in dotted lines.

If the section of the cab, tender, and carriages were uniform, there would be an upward current over



the front of the cab, carrying on horizontally, without any downward tendency whatever, and the windows would keep perfectly clear.

In my book "The Resistance of Express Trains," I advocated the enlarging of the tender to the size of a carriage, with smooth doors covering up the coal; also the abolition of "eaves" to the front of the cab. Both these suggestions were put forward simply with the idea of reducing air resistance, which would, of course, be done to a marked extent, without realising this further important advantage that would accrue. The effect could easily be ascertained, either by a full-scale experiment, or by means of models in one of the wind tunnels at the National Physical Laboratory.

Any student of aerodynamics would agree that the front top corner of the cab is an extremely critical place. The roof should never project a hair's breadth. If possible, the angle should be rounded off, though this is a difficult matter on a modern engine. It has, nevertheless, been done in the case of some fairly large French ones. It is doubtful whether the little windows sometimes placed above the top of the fire-box are much good; probably only those at the sides are of any real use. If this is so, the cab could curve up with a liberal radius, which would greatly improve the air flow.

Another still more critical place is the outer front edge of the smoke-box, which should be rounded off. A prominent bulge in the door, put in with the best of intentions, will be surrounded by a ring of furious eddies, unless the entire contour consists of one smooth curve, as is the case on some of the latest P.L.M. engines.

The shape of chimneys is discussed at some length in my book. I would add that the application of a rim close round the top interferes with the currents induced by the issuing jet, and produces another set of eddies, with an effect something like a ring of little hooks projecting into it.

If express engines burnt oil instead of coal, it would be easy to provide for their normal running to be with the fire-box in front, which would be an ideal arrangement for several reasons. There would be a fine view, and the upper three-quarters of the engine could be given a beautiful stream-line form, but it is not feasible with coal. Nor would it be desirable, as has been suggested, to put the driver in an isolated position in front.

The conclusions at which I have arrived, and which I have set down here and elsewhere, on the subject of air currents round trains, are not mere speculations, but are carefully considered deductions from the mass of information which has been built up by thousands of experiments with aircraft, the bearing of which on their own problem railway engineers do not at present appreciate and take advantage of.

Personally, I am of opinion that every railway building its own engines ought to have its own wind-tunnel, and try the effect, by means of a model, of every modification of external shape that was proposed to be introduced in express engines. It would soon pay for itself in saving of coal, and would eventually lead to the engines being completely changed in outward appearance.

Metal Airship Construction.

No. II. *(conclusion).*•

IN addition to the rolling and drawing of the various sections in stainless or other steel, and in duralumin, Messrs. Boulton and Paul's contract with the Air Ministry for the hull structure of the airship "R 101" involves the manufacture of a large number of joints, sockets, shackles and other details in the production of which many special machining problems are presented. These machining operations derive their interest from the fact that while the parts are required in large numbers, those of one given kind are not all identical and have to be made with great accuracy to differing angular dimensions. As an example, we may take the stampings which form the joints between the transverse polygonal frames and the longitudinal girders. The elevational outline of the ship has to conform to a prescribed stream-line form. The joint stampings at each frame have therefore to be made of the same general form, but with angular dimensions appropriate to the curvature of the hull outline at the particular frame at which they are to be used.

It may be noted that the equation to the stream-line form of the hull outline is of such a kind that it is impossible to calculate the length of a chord of the curve by any direct mathematical process. In order to determine such dimensions as the length of the inner and outer longitudinal girder booms, it was assumed that between each pair of transverse frames the curve of the envelope could be replaced by an arc of a circle. The main longitudinals are equivalent to an arc of 1 deg. or 2 deg. of a circle, having a radius of the order of a quarter of a mile. In a number of cases the critical figure required was the small difference between two considerable magnitudes. To obtain that difference with the requisite degree of accuracy, it was sometimes necessary to calculate the magnitudes involved to fifteen significant figures. Such calculations were beyond the aid of any table of logarithms in existence, and had to be carried out by direct arithmetical computation.

In Fig. 6A we illustrate the joint stampings referred

• No. I. appeared November 30th.

to above. These stampings are all of one pattern as received, the required angular differences being formed during the machining processes. It follows that the stampings have to be provided with more than the usual machining allowances. As a consequence, one of the problems which have had to be solved was to devise a means of holding the work in the machine in such a way as to eliminate or minimise the distortion produced by the removal of relatively large amounts of metal. The views given in Fig. 6A show the stampings in the rough state as received, set ready for milling the angular lugs, lightened and finished. After the centre line has been marked off, the first operation consists of spot facing the three lugs at the vertices of the triangle. This operation is carried out on the jig shown to the right in Fig. 6B. In all subsequent operations the part is clamped down on these three faces alone, a procedure which imposes the minimum possible jig constraint on the stampings, and as a consequence secures the desired absence of distortion during the machining process. The next operation consists of milling, drilling, and reaming the lugs at the triangular vertices. On the left of Fig. 6B the stamping is shown in the drilling jig. These lugs are used for location purposes in the subsequent operations. The next operation consists of rough milling the angular lugs at or near the centre of the triangle. Thereafter the stamping is lightened, a fixture being used which allows the work to be quickly clamped in any position, and which locates the stamping accurately in three angular dimensions. The final operation consists of finish milling the angular lugs and drilling them. The jig used for this purpose is shown in Figs. 6C and 6D, taken apart and with the work in position respectively. The jig can be set to various angles about a horizontal and a vertical axis to give the required inclination to the milled faces and drilled holes of the lugs. The drilling, it may be noted, is performed without removing the work from the milling machine, a special drilling attachment being provided to that end. The angular settings of the jig are graduated, not in degrees, but in numbers corresponding to the number of the part being machined. These part numbers are stamped on the work before it is removed from the jig. The inspector's duty consists of seeing that the part numbers are correctly transferred from the jig to the work, and that the part fits the jig as set. In this way confusion in the assembly of a large number of parts, angularly different among themselves, is avoided.

A somewhat similar series of machining operations is carried out on the stampings illustrated in Fig. 7. These stampings are used to connect the inner rings of the transverse polygonal frames with the radial struts, whereby the inner and outer rings are united. In this case no bolt holes were available to serve the purpose of locating the work in the jigs. The procedure adopted was to have an extra piece stamped on between the top jaws to receive a locating pin in the jigs, the remainder of the location being obtained by inserting one of the lugs of the stamping into a slot in the jig. The first operation consists of spot milling both sides of the stamping. After the centre line has been marked off the hole for the locating peg between the top jaws is drilled and reamed. The stamping is then placed in the jig shown in Fig. 7F and the end lug is milled for purposes of subsequent location. The side lugs are next milled, after which the top jaws are roughly milled. The finish milling of the top jaws is carried out in the jig shown in Fig. 7G, which provides two angular settings. The jaws are thereafter drilled in the jig shown in Fig. 7H. This jig is also employed for drilling the central bolt hole. The remaining operations consist of milling the centre bolt hole bosses and lightening the stamping.

The oblique sockets which connect the radial struts to the inner and outer rings of the transverse polygonal frames are shown in Fig. 8J. These sockets are die castings, and are milled and drilled to a series of angles by rotation about two principal axes. The operations performed on the castings consist of boring the tube sockets, milling and drilling the lug and profiling the lug. The boring jig is shown in use in Fig. 8K, and

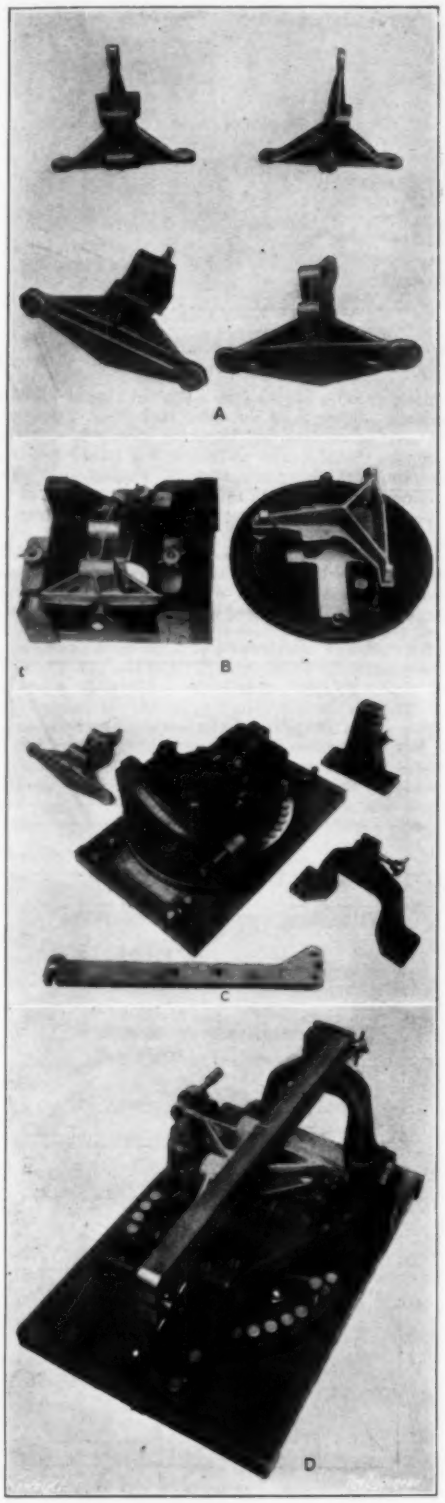


FIG. 6—MACHINING JOINT STAMPINGS

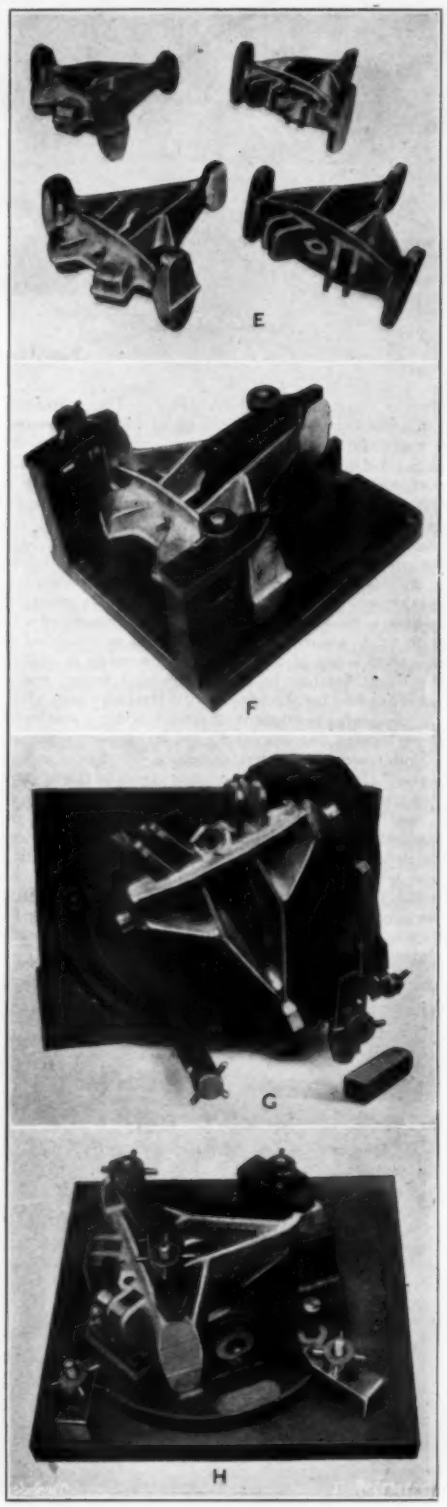


FIG. 7—MACHINING JOINT STAMPINGS

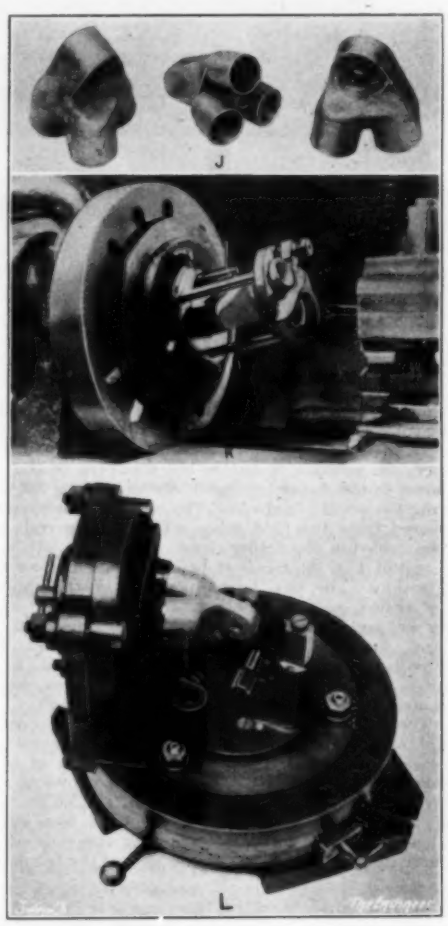


FIG. 8—MACHINING OBLIQUE SOCKETS

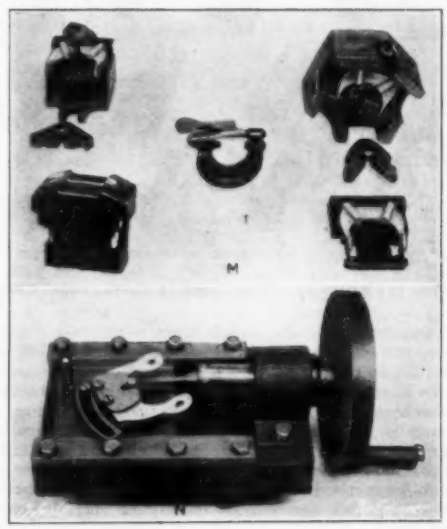


FIG. 9—PRODUCTION OF WIRING SHACKLES

is rotatable to give the three positions required for the three sockets. The jig employed for milling and drilling the lug is shown in Fig. 8L. The work is located from the drilled sockets and can be rotated about a horizontal and a vertical axis against graduated scales on the jig.

A very large number of wiring shackles are required to carry the swaged rod bracing of the main longitudinal girders. Each shackle is united to the booms of the girders by a single bolt passing through the shackle eyes, and each is drilled and tapped to take two bracing rods, which tie the three booms of the girder together from corner to corner of the panels into which the tubular struts divide the girders. The production of these shackles is illustrated in Fig. 9. The first operation consists of setting the stamping in the jig, shown in the lower left-hand corner of Fig. 9M, and filing the profile to shape. The work is subsequently located from the filed faces. The shackle ends are then milled in the fitting shown in the top left-hand corner of Fig. 9M, the feed being applied in a vertical direction. The two barrel portions of the shackle are drilled in the jig shown in the top right-hand corner, and thereafter these holes are tapped in the hand tapping machine, shown in Fig. 9N. The threads are required to be strictly to B.E.S.A. tolerances, and it is found that these tolerances cannot be maintained if machine tapping is employed.

The transverse polygonal frames are fifteen sided, and, as shown in Fig. 2, *ante*, are each composed of a series of inner ridge girders and two series of outer ridge girders. While the inner ridge girders join up to form a fifteen-sided polygon, the outer ridge girders are joined by members known as base struts. These struts, in addition to uniting the ends of the outer ridge girders, serve as the base of the triangular frame longitudinals, which unite with, and continue the run of the main longitudinal girders. The base struts are tubular sections fitted with fork ends, and are illustrated in Fig. 10. The fork ends are finish machined and inserted loosely on the tubes. The member is then placed in the jig—shown in Fig. 10—and drilled and reamed for the shear bushes and tubular rivets employed to attach the ends to the tubes. A similar method is employed throughout for obtaining the required degree of accuracy in the dimensions of girders, &c.

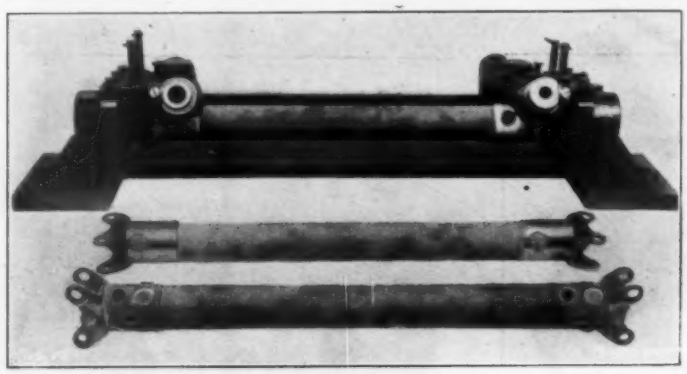


FIG. 10—BASE STRUTS

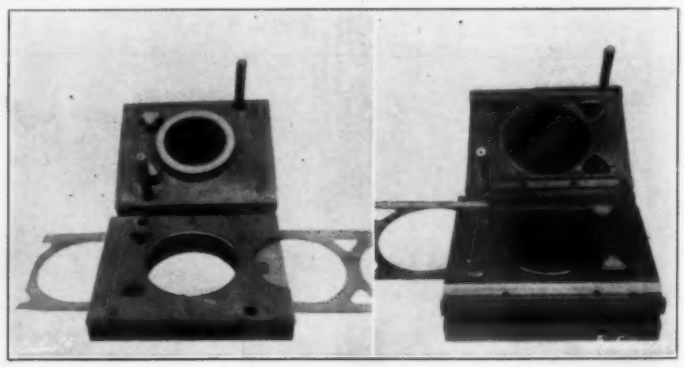


FIG. 11—PUNCHING AND FLANGING GIRDER WEBS

The webs of the ridge girders and radial struts are formed of duralumin sheet, and are lightened by large circular and small triangular holes. The punching of the strip is performed by means of the tool shown to the left, in Fig. 11. After punching the strips are treated in a salt bath, and are completed by flanging the sides and the lightening holes by means of the tool shown to the right in Fig. 11.

While the "R 101" is distinguished from other airships by the fact that the transverse frames are not stiffened by cross wires or cables, there is still a considerable amount of cable bracing employed in the structure principally, as indicated in Fig. 1, *ante*, for stiffening the structure longitudinally. It will be noted from that engraving that diagonal cable bracing is applied in every panel formed by two adjacent transverse frames and two adjacent longitudinal girders. The cables employed are fitted with conical end pieces of a variety of sizes—see Fig. 12—which are attached to the cable ends by means of the "cazin"—cadmium-zinc—solder, of which particulars were given in our first article. The cables are cut to length by laying them along a V-trough, a plain piece of 2½in. by 2½in. angle iron, which has a steel tape measure stretched along one face. Split clamps are slid along the cable to the desired measure, and are there clamped in place. The cable is then cut through just outside the clamps. The cable ends are thereafter splayed out, and the conical pieces slipped over them to butt against the clamps. The terminal is next heated with a small gas blow flame and sweated up with the "cazin" alloy. In this way a solid conical end accurately fitting the interior of the conical piece is given to the cable. After the projecting end of the cazined portion has been ground off square the fork end is fitted to the coned piece. When completed in this manner the cable is loaded to 50 per cent. of its breaking load to bed the end cone into the fitting and generally to stretch the cable so as to take up initial permanent set. The stretching machine is illustrated in Fig. 13. It consists of a long bench with a winch at one end and a weighted and calibrated lever at the other. The cable is attached by its end fittings to the winch and lever, and the load is applied by the winch until the lever arm lifts.

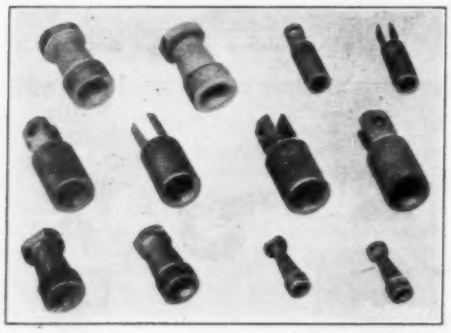


FIG. 12—CONICAL ENDS AND FORKS FOR CABLES

A considerable amount of research work was carried out by Messrs. Boulton and Paul on cables preparatory to undertaking the manufacture of those required for the "R 101." Attention was given to the apparent Young's modulus possessed by a cable complete with its end fittings. It was found that the modulus obtained when the cable was first loaded was deceptive because of the permanent set or pulling in of the ends which occurred. After the cable had been loaded to 50 per cent. of its breaking load no further permanent set was noticed. For all sizes of cable from 25 cwt. up to 135 cwt. the apparent value of Young's modulus was found to range from 10,000 tons to 11,000 tons per square inch. For cables above the 135 cwt. size the apparent modulus was only of the order of 8000 tons. Attempts were made to increase this value by the use of various types of end fittings, but no success was obtained. The falling off in the value of the modulus coincided with a change in the structure of the cable from 37 strands of single wire to 7 strands each composed of 7 single wires. As an outcome of this investigation no cable above the 135-cwt. size has been used. Where larger cables are required, duplicate cables of a smaller size are employed. A typical example of the stress-strain curve obtained from a 120-cwt. cable illustrating the hysteresis effect is given in Fig. 14.

FIG. 13—CABLE STRETCHING MACHINE

An investigation was made to discover the possible existence of creep in the made-up cables. Specimens were suspended for long periods with dead weights attached to their ends. The stress employed was of the order of about 25 tons per square inch. A typical example of the results obtained may be quoted. A 45-cwt. cable loaded with 11 cwt. for 282 hours crept 0·065in. on a length of 99in. This extension was recorded during the first few hours of the test, after which no further creep was noticed.

Tests of the reliability of the made-up cables were carried out by loading specimens and their end fittings to destruction. It was found that in almost all cases the actual strength of the cable was about 8 per cent. in excess of its nominal breaking strength, and that in no case did the cable or end fitting fail at less than the nominal strength. Out of twenty-four cable specimens tested eleven failed by the breaking of the cable, six by the shearing of the pins, and seven by the failure of the fork ends.

Having described the manufacture of certain of the components of the airship structure we may now turn briefly to one or two examples illustrating the assembly of the structural members as carried out at Norwich before they are despatched to Cardington for building into the hull.

FIG. 14—STRESS-STRAIN CURVE FOR A CABLE

The ridge girders of the polygonal transverse frames are of triangular section and are formed of three punched webs of the design shown in Fig. 11, united by three booms rolled to an open tube section, the edges of which are turned radially outwards for attachment to the webs. After the webs and booms have been cut to the exact length required they are assembled in the jig shown in Fig. 15R, which is provided with standard plug ends on to which the booms fit. The drilling is completed while the girder is in this jig, and before it is removed a certain number of rivets are driven in it. The remainder of the riveting

is performed on the bench with pneumatic tools after the girder has been removed from the jig.

After the girder has been completely riveted the fork ends are fixed in the ends of its booms by means of the jig shown in Fig. 15s. One of the end frames of this jig is fixed in position. The other is set to the required spacing by means of a standard end rod. The fork ends are assembled in the booms and, when the girder is placed in the jig, are attached to corresponding members on the end frames of the jig. In this setting the fork ends are fixed by drilling and passing a taper pin through the drilled hole. The final pinning of the ends in position is carried out on the bench. Subsequently the girder is returned to the jig for inspection.

The radial struts uniting the inner ridge girder of

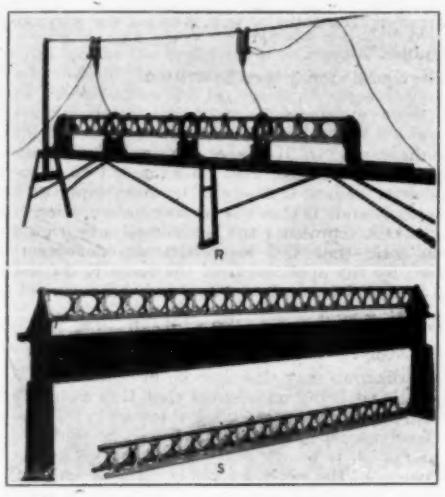


FIG. 15—RIDGE GIRDER ASSEMBLY

each transverse frame to the two outer ridge girders consist, as shown in Fig. 16p, of central portions resembling the ridge girders shown in Fig. 15. The three booms of each strut end in sockets which are used to unite the strut to a pyramidal tubular member shown under assembly in Fig. 16o. The triple socket in which these three tubes unite and by which they are united to the ridge girders has already been mentioned and is illustrated in Fig. 8j. The purpose of the jig shown in Fig. 16o is to control the size and angles of the pyramid. The length of the tubes is determined beforehand by means of an adjustable end gauge. The assembly of the complete double radial struts is illustrated in Fig. 16p. The jig

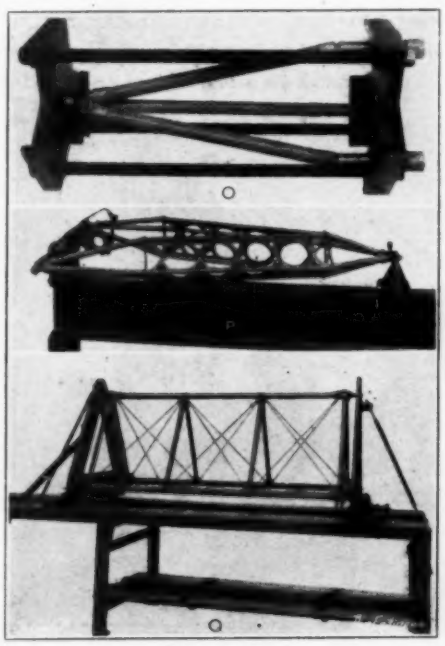


FIG. 16—RADIAL STRUTS AND FRAME LONGITUDINAL

employed reproduces the geometrical conditions which have to be satisfied. The right-hand head of the jig is dowelled in position after it has been set by means of a standard end bar the required distance from the left-hand head. The left-hand head carries a bar with faces at its ends for the support of the pyramid sockets. This bar is set to the required angle by means of an inclinometer attached to it.

The assembly of the frame and main longitudinals, as shown in Fig. 16q and 17 respectively, is carried out between jig plates mounted on steel benches. The end plates carry fittings set out to the standard triangular section of the longitudinals and are fixed at distances apart determined by end rod measurements. The two inner booms of the longitudinal are, by reason of the curvature and slope of the hull outline, different in length from the outer boom and are not square beneath it. The end plates of the jig are therefore not set vertical or parallel, but are inclined at angles determined by careful plumb bob measurements. The fork ends are held by the jig in correct position relatively to the booms, and while so held they and the booms are drilled for the receipt of the tubular rivets. All the longitudinals are cambered to suit the curved outline of the airship hull. The cambering is given to them in the assembly jig by tightening the bracing rods of the girder, measurements being made from the bench surface at different points.

FIG. 17—ASSEMBLY OF MAIN LONGITUDINALS

The general section of the airship is, as we have said, fifteen-sided. Towards the after end, however, namely, between frames 12 and 13, the section changes to a sixteen-sided polygon, the object of the change being to facilitate the building in of the cruciform tail structure. The change presented a somewhat complicated problem from the point of view of the production of the longitudinal girders. The special form of main longitudinal constructed to accommodate this change of section is illustrated in Fig. 18. The procedure adopted was to set the frame longitudinals for the two frames 12 and 13 in their correct relative positions and to build the main longitudinals between them. The frame longitudinals for this purpose were assembled on jigs which were provided with fittings to carry the fork ends. These fittings could be adjusted vertically and about a vertical axis.

A word or two may be said by way of conclusion

FIG. 18—SPECIAL FORM OF LONGITUDINAL

regarding the special processes adopted for the protection of finished parts of the airship structure against corrosion. Those steel members which are not made of stainless steel are treated by the well-known Sherardising process. This rust-proofing process is found to yield uniform results if close control is exercised over the density of loading of the work into the drums, the composition of the zinc-zinc-oxide mixture, the rate of increase of temperature, and the maximum temperature, and the time for which the parts are allowed to soak at the maximum temperature. It has been found possible to control the thickness of the coating to within very close limits. We are informed, in fact, that it is quite safe to count on an increase in dimensions caused by the coating which will always lie between 0·0003in. and 0·0006in. Messrs. Boulton and Paul state that the rust-proofing provided by this process is in every way superior to that obtained by the electro-deposition of zinc. The coat is well alloyed to the steel, and is found to be non-porous by every test that can be devised for it. Among the many thousands of steel stampings, tubes, &c., treated by the process, less than a hundred have had to be rejected and sent back for re-treatment.

The aluminium-silicon alloy used for the die castings has such an excellent natural resistance to corrosion that no process for that purpose is applied to it. All the duralumin used in the structure—the only other form in which aluminium enters into it—is coated with a film of oxide by the anodic oxidation process, and is thereafter smeared with lanoline. Messrs. Boulton and Paul own, it may be noted, the largest anodic oxidation plant operated under the patents of the Department of Scientific and Industrial Research. This process is applied to all the duralumin parts used in the airship structure, from the smallest rivets to solid-drawn tubes, $2\frac{3}{4}$in. in diameter and 30ft. in length. The operation of the process in a successful manner requires a very close control over the loading of the plant with respect to current density. This loading varies with the composition of the alloy and the state of the surface; that is to say, whether it has been machined, stamped, rolled, pickled, &c. Very close control is also required over the rate of voltage rise, the duration of the soak at the film forming pressure of 40 volts, and the concentration of the chromic acid electrolyte in the bath. After having treated many thousands of square feet of surface, Messrs. Boulton and Paul are not in a position to relax in any degree the closeness of the control which is exercised during the carrying out of the process. The process, it is very interesting to note, has proved an invaluable aid to the inspection of duralumin parts. It exercises a selective attack on faulty places and immediately reveals flaws, segregations, &c., which are masked to ordinary inspection.

The Possible Vibration of a Ship's Hull under the Action of an Unbalanced Engine.*

By Professor W. E. DALBY, F.R.S.

THE President of the Institution, expressing the wish of the Council, invited me to give the Thomas Lowe Gray Lecture this session, and suggested that the subject should have some relation to the balancing of engines and the vibration of ships. To a member of the Institution such an invitation is a command. I at once began to think how to present to you in the course of an hour the principles on which our practice must be founded if we are to solve successfully problems arising out of the vibration of ships under the burden of unbalanced machinery. I decided that the lecture must be in the main experimental, leaving the mathematical details in the background, but available for reference. Unfortunately, such an experimental lecture cannot be repeated or delegated at local centres, and I therefore reluctantly decided that I should have to forego the pleasure of repeating the lecture before the local branches of the Institution.

1. *The Action of an Unbalanced Engine on the Hull.*—The accelerations of the unbalanced parts of an engine cause pulsating forces and couples to act on the hull. Consequently the hull itself is forced to vibrate.

What is the amplitude of this forced vibration? Before this question can be answered we must ask another. What are the natural modes of vibration of the hull?

If the natural frequency of the vibration of the hull is equal to the frequency of the applied pulsations

* The Institution of Mechanical Engineers. Second Thomas Lowe Gray Lecture.

from the engine, vibrations of large amplitude result, and were it not for the damping effect due to frictional resistance the amplitude would reach dangerous dimensions. If the pulsating force applied to the hull by the unbalanced engine differs in frequency considerably from the natural frequency of the vibration of the hull, the amplitude of the vibration forced on the hull is small.

In general the dynamical relations between the action of an unbalanced engine and the response of the hull are complex, but the study of a simplified system is instructive and brings out the fundamental relations.

First of all, therefore, I propose to draw your attention to a simplified treatment set out in my book on "The Balancing of Engines" under the chapter headed "Vibration of the Supports."

2. *The Amplitude Frequency Diagram for a Simple System of Natural Frequency* $\frac{q}{2\pi}$ *Vibrations per Second.*—The simple system—Fig. 1—is a mass M concentrated at the centre of a beam of negligible mass in comparison with M and forced into oscillation by the action of a vertical alternating force E cos $p\,t$. We may suppose that M contains inside it an engine which rotates a mass m at radius r feet n times per second. The vertical component of this applies to M an alternating vertical force E cos $p\,t$, where p is the angular velocity of rotation of m. The frequency in revolutions per second is given by $n = \frac{p}{2\pi}$. The maximum value of E in pounds can be calculated from the expression $1{\cdot}22\ m\ n^2\ r$.

The oscillation of the beam is resisted by frictional

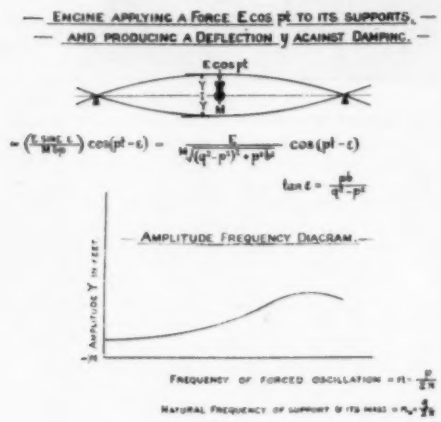

— ENGINE APPLYING A FORCE E cos pt TO ITS SUPPORTS, —
— AND PRODUCING A DEFLECTION y AGAINST DAMPING. —
E cos pt
M
— AMPLITUDE FREQUENCY DIAGRAM. —
AMPLITUDE Y IN FEET
FREQUENCY OF FORCED OSCILLATION
NATURAL FREQUENCY OF SUPPORT & ITS MASS

Fig. 1

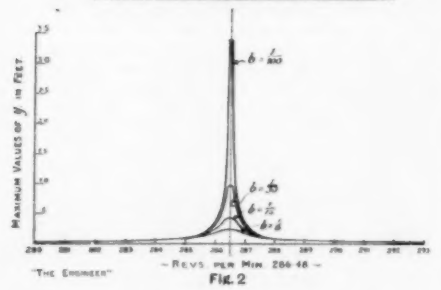


Fig. 2

resistances which are generally assumed to vary as the velocity. Let δ be the value of these frictional resistances when the velocity is 1ft. per second, and μ the force which when applied at the centre will deflect the beam 1ft. Assuming that the mass in motion is concentrated at the centre and is equal to M, the equation of motion is

$$\frac{d^2y}{dt^2} + b\frac{dy}{dt} + \frac{\mu}{M}y = P\cos p\,t,$$

where $b = \frac{\delta}{M}$, $P = \frac{E}{M}$.

The solution of this equation is :—

$$y = \frac{P\sin\varepsilon}{p\,b}\cos(p\,t - \varepsilon) \quad \cdots\cdots (1)$$

where the value of ε, which fixes the phase, is given by

$$\tan\varepsilon = \frac{p\,b}{q^2 - p^2}$$

Also $$M\,q^2 = \mu \quad \cdots\cdots\cdots\cdots (2)$$

The expression for y, the half-amplitude of the oscillation, can be written, eliminating $\sin\varepsilon$,

$$y = \frac{P}{\sqrt{(q^2-p^2)^2 + p^2b^2}} = \frac{E}{M\sqrt{(q^2-p^2)^2+p^2b^2}} \quad (3)$$

Assuming the maximum magnitude E of the applied force to remain constant, but its frequency $n_p = \frac{p}{2\pi}$ to vary, then the semi-amplitude of the oscillation depends only upon the value of the denominator in (3).

This quantity depends for its magnitude on the damping coefficient b, and on the relative values of q and n.

When $q = p$ there is synchronism, and then

$$y = \frac{P}{p\,b}$$

If the damping b is small then y becomes large; in fact y tends to infinity as b tends to zero.

The effect of b in modifying y is illustrated in Fig. 2, which is reproduced from my book on "The Balancing of Engines," page 208 in the second edition. The values used are P = 1. Synchronising speed, 286·48 r.p.m. = 4·778 periods per second.

Curves are plotted for the various values of b written above them.

3. *Graphic Representation of Equation* (3).—The

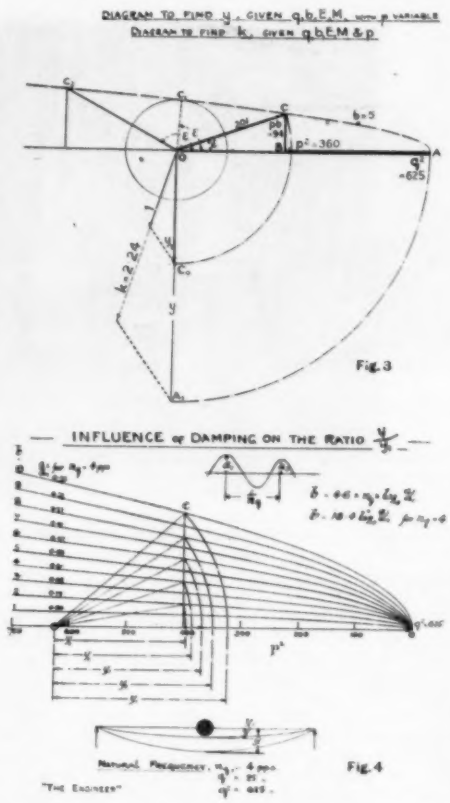


Fig. 3

Fig. 4

relations between the quantities can be studied by means of the diagram shown in Fig. 3.

The object of the diagram is to evaluate the denominator of the expression (3), P being maintained constant.

The Diagram (Fig. 3).

Set out from any origin O the line O A $= q^2$.

And from A set back, A B $= p^2$.

At B erect a perpendicular B C $= p\,b$.

Then C O $= (O\,B^2 + B\,C^2) = \sqrt{(q^2-p^2)^2 + p^2b^2}$.

With P constant the locus of the point C for a given value of b is a parabola with its vertex at A.

A line drawn from O to this parabola is a vector defining the conditions of the motion for the given damping b. If the line is drawn to a point near the vertex the frequency of the applied force E is small, and the semi-amplitude tends to a value

$$y = \frac{P}{q^2} = \frac{E}{M\,q^2}$$

But $M\,q^2 = \mu$. So that y tends to the value $\frac{E}{\mu}$ which is the deflexion produced by the force E applied statically.

If a circle is struck from the origin to touch the parabola, and a vector O C_1 drawn from O to the point of contact, then O C_1 is the minimum value of C O and therefore determines the maximum value of the semi-amplitude y. The lag ε is nearly 90 deg.

If the line be drawn to the left as O C_2 the length of O C_2 begins to increase indefinitely, so that y decreases and ε, the angle, increases toward 180 deg.

4. *The Dynamic Magnifier.*—A useful quantity has been defined by the Bridge Stress Committee with special reference to the oscillation of railway bridges caused by the hammer blow from the locomotives, although it is equally useful in relation to ships' hulls.

Multiply numerator and denominator of equation (3) by q^2. Then it has already been shown that $\frac{E}{M\,q^2} = y$, the deflection due to the force E applied statically. The ratio $\frac{y}{y_1} = K$ is called the "dynamic magnifier."

The equation may then be written

$$\frac{y}{y_1} = \frac{q^2}{\sqrt{(q^2-p^2)^2 + p^2\,b^2}} = K$$

The diagram (Fig. 3) implies the dynamic magnifier, and the construction may be extended to show it explicitly. Since O A $= q^2$, the numerator of the equation, and O C $=$ the denominator, then the length O A represents the semi-amplitude y on the same scale that O C represents the deflection y_1 caused by the application of the force E statically. O A is turned vertically to O A_1 and O C is turned on to it at O C_0 so that the ratio $\frac{y}{y_1} = \frac{O\,A_1}{O\,C_0}$ may be compared easily.

The diagram may therefore be interpreted to give this ratio, it being understood that E is assumed to remain constant in magnitude but to vary in frequency.

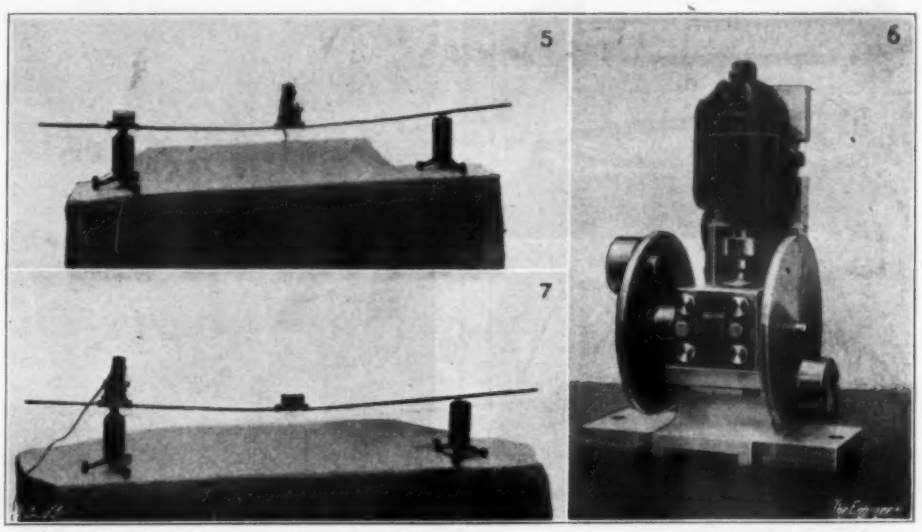
The dynamic magnifier K, as will be understood from Fig. 3, is nearly unity when the value of the frequency of the applied force is small or large relatively to the natural frequency of the vibrating system. It increases in magnitude as synchronism is approached, becoming a maximum just before synchronism.

5. *The Influence of the Damping Coefficient on the Semi-amplitude of the Forced Oscillation.*—This can be studied in the diagram Fig. 4. The diagram is drawn for a simple system whose natural frequency is four periods per second. Damping parabolas are drawn in for values of b from 1 to 10.

Draw any line O C across the diagram. A perpendicular from C cuts the base at 400, corresponding to a frequency of 3·2 periods per second. Then the various lengths cut off on this line by the damping parabola define a range of values for y_1 in relation to y.

It will be seen at once what a powerful influence a small increase in b has upon the magnitude of the semi-amplitude of the forced oscillation.

A model is exhibited in which a vector arm is centred at O_1 so that it can be turned out at any angle, so defining the value of p and the ratio $\frac{y_1}{y}$. It should be understood that the actual value of y is found from



FIGS. 5, 6 AND 7

K and $y_1 : y_1$ is calculated from $\frac{E}{\mu}$, if μ is known, or from $\frac{E}{M\,q^2}$, if q is known.

The diminishing value of the semi-amplitude in an oscillation dying away enables the values of b to be found if the ratio of successive semi-amplitudes can be measured. Thus (Fig. 4), as is well known, the ratio $\frac{a_2}{a_1} = \varepsilon^{-\frac{b}{n_q}}$ therefore

$$2{\cdot}3\log_{10}\left(\frac{a_2}{a_1}\right) = -\frac{1}{2}\frac{b}{n_q} \quad \cdots\cdots (1)$$

The values of $\frac{a_2}{a_1}$ have been calculated from I for the value of b written on the curve, and for $n_q = 4$ these are :—

b	$\frac{a_2}{a_1}$	
1	0·882	
2	0·78	
3	0·68	
4	0·60	$n_q = 4$
5	0·53	$q = 25$
6	0·47	$q^2 = 625$
7	0·41	
8	0·37	
9	0·32	
10	0·28	

Values below 4 represent heavy damping.

6. *The Model of a Support Burdened with an Unbalanced Engine.*—I have constructed specially for this lecture the apparatus illustrated in Fig. 5. A flexible beam, representing a flexible hull, rests on massive supports which do not constrain its ends. It is the foundation or support of what is essentially a small unbalanced engine. The position of the engine can be changed along the beam. The engine itself—see Fig. 6—is a rotating shaft driven through worm and worm wheel by a small motor. The speed can be varied from 0 to about 200 r.p.m., and can be maintained at a constant value within this range by the resistance controlling the motor speed. Masses can be attached to the shaft to throw the engine out of balance.

With no masses on the shaft the engine is in balance. Masses can be attached so that the vertical components of their motion are in phase or differ in phase by 180 deg., so that we can apply a pulsating force or a pulsating couple to the beam.

A series of experiments may then be performed exemplifying the general principles :—

(1) No balance weights on the engine. The engine runs at any speed within its range and produces no oscillation on the model hull.

(2) Engine running with balance weights attached and arranged to be in phase so that they apply an alternating force to the hull. The hull responds with an oscillation.

(3) Balance weights 180 deg. apart applying an alternating couple to the hull. There is no visible response.

(4) The position of the engine is changed to a node of the hull, which in the model is over one of the supports, as illustrated in Fig. 7. A mass is placed at the centre of the hull in order to keep the total mass of the oscillating system constant. The

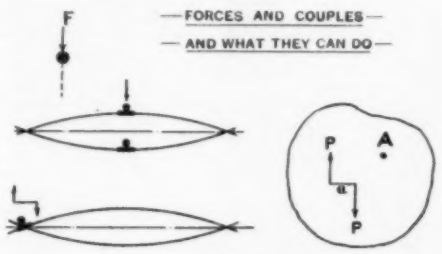


Fig. 8

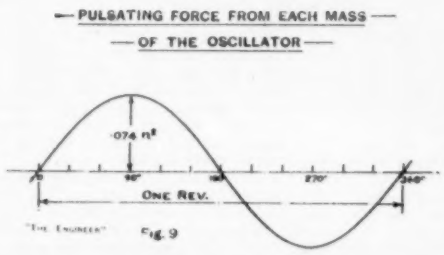


Fig. 9

engine now applies a couple at the node. The result is oscillation of the hull.

(5) If the balance weights are changed so that they are in phase there is no oscillation of the hull.

These experiments show how differently a hull responds to a pulsating force or a pulsating couple. Let us consider an element at the centre of the hull, Fig. 8. It is free to move up and down in a line. The pulsating force can therefore set it in motion and cause oscillation. The pulsating couple can only twist the element, and as the element is not free to twist it cannot produce motion.

Let us now consider an element over a node or support. The support prevents it from moving in a line, but does not prevent it twisting. The pulsating force can only produce motion in a line and therefore has no effect over a node, when the element is free only to twist. But, as demonstrated, the pulsating couple is able to set the hull in oscillation because it can twist, and the element is free to twist.

The conclusion is of considerable practical importance. If the type of engine to be fitted to a vessel is known to apply a pulsating force to its support the best place to put it is over a node. If, on the other hand, like the three-cylinder compound marine engine with cranks at 120 deg., it is known to apply a pulsating couple to its support the best place to put it is centrally between two nodes.

The experiments illustrate a principle which is fundamental in dynamics, namely :—

(1) A force can produce motion only in a line and can in no circumstances cause rotation.

(2) A couple can produce rotation only and can in no circumstances cause motion in a line. And conversely all rotation, or turning, or twisting is the result of the action of a couple. Where such rotation, turning, or twisting is said to be the result of a force having moment about an axis, the nomenclature should be amended to moment of a couple, because though only one force may be visible, the other is there as a reaction.

7. *Synchronism.*—The effect of coincidence between the natural frequency of vibration of the hull and the

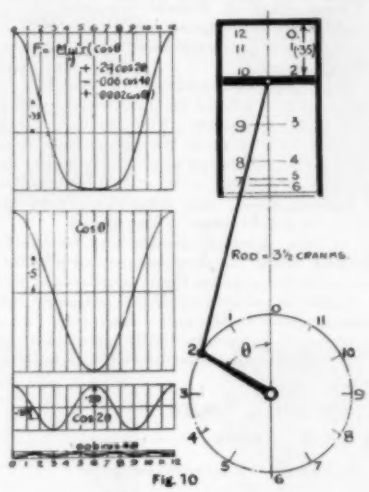


Fig. 10

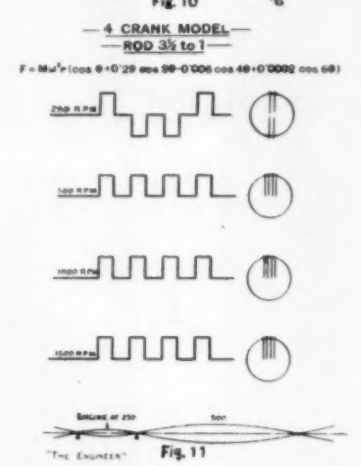


Fig. 11

applied pulsation is shown by means of the experimental apparatus. The natural frequency of the apparatus is about 140 vibrations a minute. When the engine is driven at 140 vibrations per minute the pulsating force applied to the model hull is 0·8 lb. This force of 0·8 lb. applied to the centre of the hull produces a deflection of $\frac{1}{16}$in. The engine itself applying this force 140 times per minute produces a deflection of about 3in. This extraordinary difference in the deflection produced by a force of the same magnitude, but applied first steadily and then as an alternating force, illustrates the effect of synchronism. The experiment is now continued to show that weights of 35 lb. placed on the model hull are necessary to produce a static deflection of 3in. We say, therefore, that the deflection due to the maximum value of the pulsations considered as a static load is magnified over fifty times by the dynamical conditions of synchronism. The speed of the motor is now increased to 320 r.p.m. and the effect is to apply a pulsating force of maximum value 4·2 lb. The deflection drops to 0·25in. or very nearly to the deflection due to the force of 4·2 lb. applied statically.

The apparent anomaly of the behaviour of the support is, however, easily explained. The applied force does work as it deflects the hull and this work appears as the energy of motion of the hull. If the applied force is timed to act so that the work done is added to the hull at each oscillation, the energy of motion of the hull increases indefinitely, and were none of it lost by frictional damping the stored energy would necessitate an amplitude of oscillation which would cause stresses in the hull beyond the strength of the material.

The applied force is correctly timed for synchronism when it is applied with the same frequency as the natural frequency of vibration of the loaded hull, that is, loaded with its own mass and the mass of its burden, the engine. This dynamical magnification of the deflection or amplitude is apparent in the records of tests of railway bridges to be referred to later.

I will, however, state here that a parallel structure to our model is the Alexander Bridge of 345ft. span. Loaded with an engine weighing 107 tons standing at the centre its natural period of oscillation is 2·16 per sec.

The engine in its passage over the bridge applies a pulsating hammer blow to the structure from the unbalanced machinery. It was found that the deflection due to the applied force considered as a static load had to be multiplied by 18 to get the deflection actually caused by its application 2·16 times per second. This is the consequence of partial synchronism.

8. *The Analysis of the Applied Pulsation into Harmonic Constituents.*—The oscillator is constructed to apply a pulsating force which varies as a sine curve, Fig. 9. But in general the variation of the pulsating force may be very different from a sine curve.

In particular the motion of the reciprocating masses of an engine differ from the sine form, and the shorter the connecting-rod in relation to the crank the greater the difference.

Fourier has placed at the disposal of the engineer a marvellous method of analysis. He has established that any periodic function may be expressed as the sum of a number of simple sine curves of different amplitudes and periods.

The forces accelerating the piston are periodic. The accelerating forces therefore can be expressed by Fourier's rule. Thus

$$F = M\omega^2 r (\cos\theta + A\cos 2\theta + B\cos 4\theta + C\cos 6\theta \cdots \text{&c.},$$

where the coefficients A, B, C, &c., are functions of the ratio of the length of the connecting-rod to crank.

If the ratio rod/crank is $3\frac{1}{2}$, the first terms of the series reduce to—

$$F = M\omega^2 r (\cos\theta + 0{\cdot}29\cos 2\theta + 0{\cdot}006\cos 4\theta + 0{\cdot}0002\cos 6\theta).$$

Fig. 10 shows these components harmonics, together

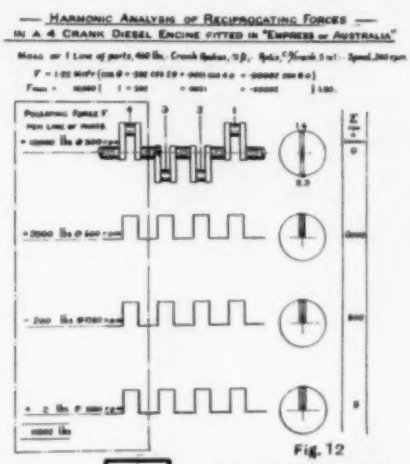


Fig. 12

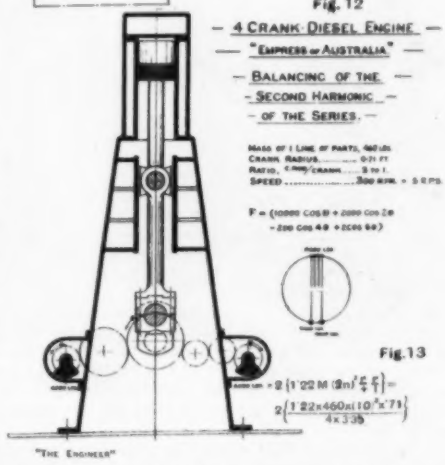


Fig. 13

with the curve which is their sum and which represents to the approximation of four times the actual force acting to accelerate the piston.

To balance such a complex force each component may be separately balanced, and the extent to which this is done is a measure of the completeness of the balancing. The advantage of this method is that each component may be balanced by means of a revolving mass driven at the appropriate speed.

9. *Experimental Illustration of the Power of a Secondary Force to Set Up Oscillation of the Same Period.*—The model is exhibited set in balance as shown in Fig. 11. From this it will be seen that the balancing is exact for primary balance, but that when driven at 250 r.p.m. it applies forces to its support of frequencies of 500, 1000, and 1500 periods per minute.

The model is attached to a flexible rod, representing a hull, supported in "V's," and when the engine is driven at 250 r.p.m. it applies to its support a force of frequency 500 periods per minute.

When, therefore, we ask the question, what will be the response of the rod representing the hull when the engine is driven at 250 r.p.m., we must get an answer to the second question : what are the natural modes of motion of the rod ? I can answer this second question because I know that the rod has a mode of

vibration with two nodes, at 500 r.p.m. If, therefore, there is anything in the theory I have presented to you, this model, driven at 250 r.p.m., ought to excite this natural mode of motion in the rod representing the hull, and you see that it does so.

10. *A Practical Example.*—The Canadian Pacific Railway built a large ship. Its hull possessed many possible modes of vibration peculiar to itself. No one troubled to find out what these modes of vibration were, so that dynamically the hull remained a mystery until the President's firm fitted in the ship a four-crank oil engine with its cranks arranged exactly as in the model.

Fig. 12 is the balancing diagram of the engine, from which you will see that it was able to apply to the hull a pulsating force of a maximum value of 8000 lb. 600 times a minute. The support itself possessed a natural mode of vibration in the region of this speed. In consequence the second harmonic of 8000 lb. at 600 r.p.m. produced an oscillation of amplitude sufficient to cause complaint from the passengers.

The connecting-rod is five cranks long. The series is therefore

$$F = 1{\cdot}22\,M\,n^2\,r\,(\cos\theta + 0{\cdot}202\cos 2\theta + 0{\cdot}00021\cos 4\theta + 0{\cdot}0002\cos 6\theta,$$

which with M = 460 lb. per line of parts, $r = 0{\cdot}71$ft., and $n = 5$ per sec., gives

$$F = 10{,}000\,(1 + 0{\cdot}202 + - 0{\cdot}0002 + 0{\cdot}00002)$$

maximum.

The cure was the addition of balance weights—Fig. 13—driven at twice the engine speed, namely, 600 r.p.m., and proportioned to balance this second harmonic. This was done and I will quote from a letter written by the President with reference to it. "This gear has been running now for the past eighteen months with very satisfactory results, and I might make the remark that without this balancing gear the vibrations of these four-cylinder engines were transmitted to the ship; especially in the saloon and dancing hall there was a very considerable amount of vibration, but after the fitting of this gear this was entirely eliminated."*

11. *Comparison of a Four and Six-crank Oil Engine.*—If the President had built a six-cylinder engine with cranks at 120 deg. and arranged that each group of three was a mirror image of the other, then using the same parts and at the same engine speed the several harmonics would be as seen on the diagram in Fig. 14.

It will be seen that when the primary forces are balanced the harmonics are balanced up to the sixth term. The imaginary crank shaft corresponding to this term shows that all the cranks point in one direction, but the force is only 2 lb., although the frequency is high, namely, 1800 r.p.m.

When a builder fits a four-crank oil engine to a ship of the type under discussion he must bear in mind that although the engine is described as a balanced engine it will apply a pulsating force of considerable magnitude to its supports at twice engine speed and he takes a risk of a hidden natural frequency responding and producing synchronous oscillations of troublesome magnitude. But if he fits a six-cylinder engine his mind may be relieved from anxiety, because although there is an unbalanced sixth harmonic, yet it is small in magnitude and is capable of developing small energy in an oscillation.

These high vibrations, however, are not entirely negligible. They may find synchronism with some part of the engine and the synchronous oscillation set up may fracture the part. Many examples of this could be cited.

I may be pardoned for drawing attention to a sentence or two in my book on "The Balancing of Engines," published in 1902. After reviewing the possibilities of balancing different types of engines without the use of bob-weights, I say:—

"Thus, an engine balanced by the rules of Art. 99, or a six-crank engine designed from Art. 100, would be in balance for forces and couples up to those of the 6*a* class. There can be no doubt but that these are the kinds of engines to use to avoid vibration. The four-crank engine cannot approach them in this respect, since, even in the best arrangement. . . . couples of the 2*a* class of considerable magnitude are left unbalanced."

It should be understood that in the six-crank engine the harmonics are balanced amongst themselves. There is no need to add bob-weights to the engine. The first set of bob-weights necessary in the six-crank engine illustrated above would be a pair driven at six times engine speed and of such magnitude and radius that their rotation provided a force of 2 lb. only.

12. *Enumeration of Possible Origins of Pulsating Forces and Possible Responses of Ship's Hull.*—There are two origins of pulsating forces, the engine and the propeller.

The ship vibrates fundamentally with two nodes, although harmonics have been detected in large ships up to the eighth harmonic. The ship can also oscillate torsionally so that it lies in the water ready to respond vertically with a fundamental and a whole range of harmonics; laterally with a fundamental and a range of harmonics; and torsionally with a fundamental and a whole range of harmonics.

Any of these dormant modes may be exalted into a dominant mode of troublesome amplitude if the harmonics of the applied force synchronise with it.

The engine in general applies a pulsating force and a pulsating couple to the hull. Each may be analysed into a series of harmonic terms, and there is possibility of neutralising these forces by balancing. The ordinary three-crank engine, with equal reciprocating masses at 120 deg., applies a large pulsating couple to the hull, but practically no pulsating force. The four-cylinder engine can be balanced to eliminate primary force and primary couple and secondary force. Secondary couples and harmonics remain. But this, the Yarrow-Schlick-Tweedy type, is only possible if the crank angles are set in a definite relation. The four-cylinder 180 deg. pair at right angles has been sufficiently considered above, and shows that it is a type which leaves a particularly large secondary force.

The variation of torque applied by the engine to the propeller shaft is able to excite torsional oscillations. The variation of pitch in the propeller can excite oscillation. The variation of weight between the propeller blades can excite oscillation, as can variation of thrust. These brief notes show the necessity of constructing propellers with accuracy, so that the pitch is constant, and the weight of each blade is the same. With turbine-driven propeller shafts variation of torque is as a rule small.

I think that now you will agree that a knowledge of the dynamical character of ships' hulls is of profound importance to the engineer who has to put in the engines. Unfortunately, there is a singular dearth of data on this subject, which may be contrasted with the wealth of data accumulated during the last few years about the dynamical peculiarities of railway bridges. These data will be of great value to future designers. The work has been done by a Joint Committee of the Department of Scientific and Industrial Research and the railway companies and has cost upwards of £25,000. The services of the railway companies and of the members of the Committee were given free.

Could not similar work be done for our shipbuilding industries by a combination of shipbuilders, engineers, and the Department of Scientific and Industrial Research?

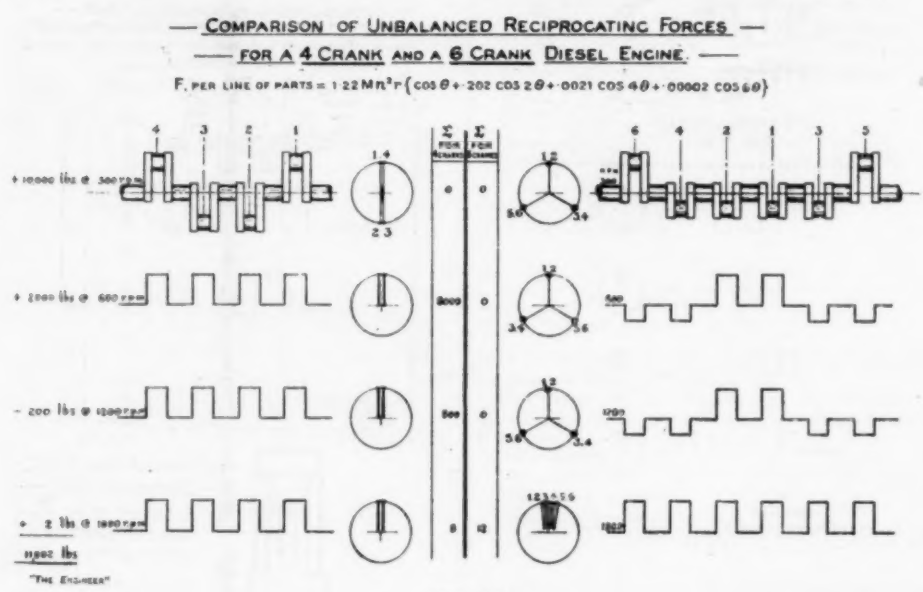

— COMPARISON OF UNBALANCED RECIPROCATING FORCES —
— FOR A 4 CRANK AND A 6 CRANK DIESEL ENGINE. —
F. PER LINE OF PARTS = 1·22 Mn²r (cos θ + ·202 cos 2θ + ·0021 cos 4θ + ·00002 cos 6θ)
4 3 2 1
1 4
2 3
Σ FOR 4 CRANK
Σ FOR 6 CRANK
6 4 2 1 3 5
1,2
3,4
5,6
+ 10000 lbs @ 500 r.p.m.
+ 2000 lbs @ 600 r.p.m.
- 200 lbs @ 1200 r.p.m.
+ 2 lbs @ 1800 r.p.m.
11992 lbs
"THE ENGINEER"

FIG. 14

* This balancing gear was described in THE ENGINEER of June 21st, 1927.—Editor, THE E.

A Visit to the Renfrew Works of Babcock and Wilcox, Ltd.

ON Tuesday last, December 4th, in company with a representative gathering of engineers and shipbuilders, we visited the Renfrew works of Babcock and Wilcox, Ltd., and inspected the firm's new boiler shops. These shops, which have recently been equipped with new machinery, are now able to deal with boilers having a total drum length of 40ft. and a diameter of 4ft. 6in., with thicknesses of plates up to 2½in. The shells and ends of the drums are riveted, and the makers regard such drums, when well designed, as suitable for working pressures up to 550 lb. and 650 lb. per square inch. In what follows a description of the sequence of operations from the reception of the plates in the boiler shop up to the final assembly of the boilers before shipment are given. In addition, we describe and illustrate a new type of chain grate stoker, which incorporates new features and may be built in widths up to 30ft.

A BOILER ENGINEERING PLANT.

In the new boiler shop the plates are first marked out and are then passed to the plate edge planer, views of which are given in Figs. 1 and 2 opposite. This planer will accommodate plates up to 40ft. in length. The saddle shown in Fig. 2 is rack driven, and is complete with its own motor, to which automatic tappet control gear is fitted.

After the "tack" holes, which are used for handling the plate and for temporary fastenings, have been drilled, the plate passes to the 8000-ton shell plate bending press, two views of which are reproduced in Figs. 3 and 4. We were able to witness the bending of a shell plate about $1^{19}/_{32}$in. thick, with a length of nearly 30ft. The press will, however, deal with plates fully 10ft. longer and of a thickness up to 2¼in. As will be seen from our illustrations, the press, which has been designed and built by Babcock and Wilcox, Ltd., consists of six independent units bolted together, each of which is provided with its own drawback gear. The bottom die holder is in two pieces, joined at the centre, and plate pinching rams are fitted, both to the top and the bottom die holders. The actual bending operation is carried out by means of a continuous roller—see Fig. 4—driven by a 25 H.P. geared motor, which gives the necessary rotary movement to the roller to feed the plate across the dies for the successive bending stages. On either side of the press—see Fig. 3—there are small plate supporting rollers which are raised and lowered by geared segments operated by hydraulic power. The depth of the bend may be varied by the stopper nuts on the columns. These nuts are interconnected by gearing, and are turned simultaneously by a motor drive. There is a large dial with a multiplying gear, which enables the press attendant to regulate the depth of the bend given.

The hydraulic controls are arranged at the opposite end of the press to that shown, and they include levers for the main drawbacks, the pre-filler valve and intensifier, and the pinching rams and roller drawbacks. When the plate is in the desired position over the dies, the roller descends and grips it with a pressure of 1 ton per square inch, after which the actual bend is made by the intensifier, which raises the pressure to 2½ tons per square inch. The main roller is then released and the press shoes freed, after which spring-controlled rollers at the top of the main roller come into operation, and by guiding the main roller uniformly throughout its length enable the rotary motion necessary for the cross feed of the plate to be effected. The main hydraulic cylinders work on a closed water circuit in which oil is used to provide lubrication for the rams. Reducing valves are fitted to give four pressures with a range of 3200, 5000, 6500, and 8000 tons.

Besides this large press, two vertical hydraulic bending presses for dealing with smaller boiler plates are provided.

Arrangements are made whereby the bent shells can be annealed in a vertical furnace over 40ft. in height, made in two halves. The annealing process generally follows immediately after the plates have been pressed to shape.

Following the bending, the sides of the shells are planed as shown in Fig. 5. The planer has a moving head, which carries the cutting tools, and is self-contained with its own driving motor. It is employed for machining the edges and the butt strap seats of the shells and is designed to take lengths up to 40ft., with a three-quarter circle of 4ft. 6in. diameter. Both edges of the shell are planed at the same time, and formers are used to obtain the correct shape of the butt strap seats. Meanwhile the butt straps have followed a machining routine generally similar to that above outlined and are ready for assembling.

The next operation is to drill the butt strap rivet holes, which is done on the eight-spindle drill—see Fig. 12, p. 632. This machine has push-button controls fitted to all spindles. It can take drums up to 5ft. diameter and a maximum length of 46ft. The maximum diameter of hole drilled is $1^{13}/_{16}$in. As will be seen, the drum is held in four-jaw chucks which are provided with rotating gear to bring the drums round to the correct centre line. A transverse adjustment is also given. After the drilling operations have been carried out, the drums are taken apart and all burrs removed from the holes, after which they are put together on the tack holes and prepared for riveting up.

A view of the riveter is reproduced in Fig. 7. It has a maximum closing pressure of 130 tons, and is mounted on a steel frame casting. The riveting post is a steel forging, and the design is such that a depth of 20ft. can be riveted with a single crane setting. When that length is completed, the drum is reversed and the other 20ft. length is dealt with. The riveter is furnished with a special reducing valve, and a timing valve, along with a water-saving gear, is fitted. The rivets are heated in oil-fired furnaces placed adjacent to the machine. The ends of the drum are then turned and bored, and the butt joint is welded for 9in. from either end.

The tube holes are first drilled in a three-spindle circumferential drilling machine, shown in Fig. 6, which is capable of pitch adjustment and always drills radially. The maximum diameter of the holes is $1^{15}/_{16}$in. The drum is held at its ends on rotating clutch gear, furnished with cross and circumferential adjustments, while the drilling spindle column can be traversed along the bed by a motor driven gear. All motions are controlled by the operator through push buttons.

BOILER ENGINEERING PLANT AT RENFREW

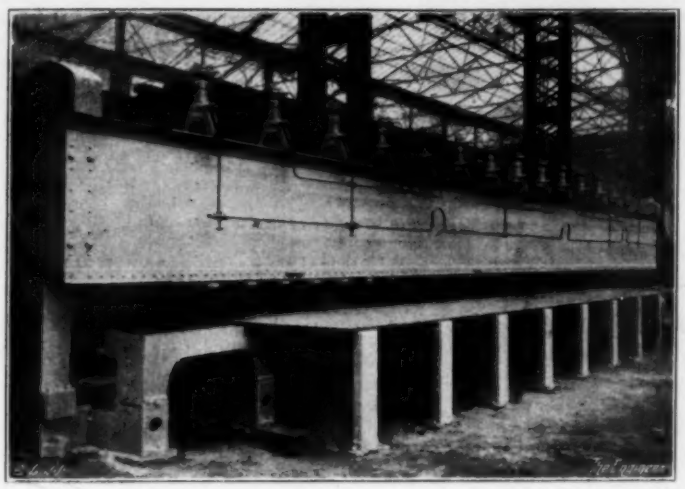


FIG. 1—PLATE EDGE PLANING MACHINE—FRONT VIEW

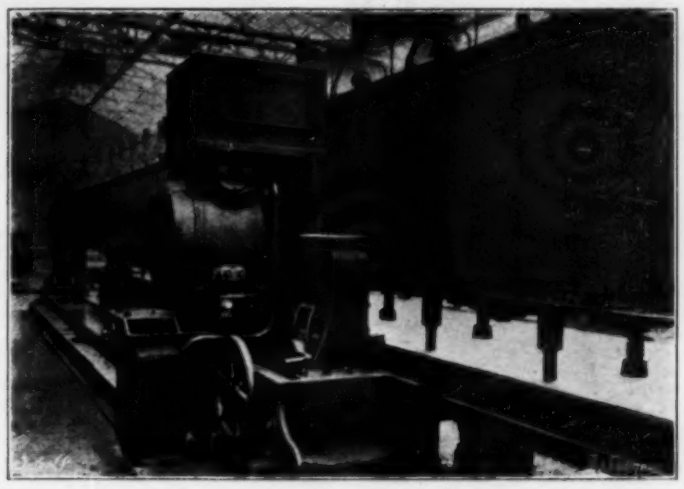


FIG. 2—PLATE EDGE PLANING MACHINE SHOWING CUTTING TOOL

FIG. 3—8000 TON SHELL PLATE BENDING PRESS

FIG. 4—END VIEW OF 8000 TON SHELL PLATE BENDING PRESS

FIG. 5—SHELL PLATE PLANING MACHINE

FIG. 6—THREE-SPINDLE DRILLING MACHINE FOR BOILER DRUMS

Following this operation, the holes are trepanned, reamed and recessed by the ten-spindle vertical tube hole drill, shown in Fig. 13. This machine deals with holes up to 4in. diameter. Tachometers, indicating drill speeds, and push-button controls are fitted.

Before the ends are shrunk on and riveted up, the inside seams and butt strip rivets are caulked by a small air-driven caulking machine, drawn through the drum on steel wire ropes.

Another interesting machine—which we do not show—is a newly designed flange and pad facing machine, which will accommodate drums up to 40ft. in length. The drum is carried in two cradles and the turning tool is carried on a horizontal head with traversing motions.

After these operations are completed, the internal

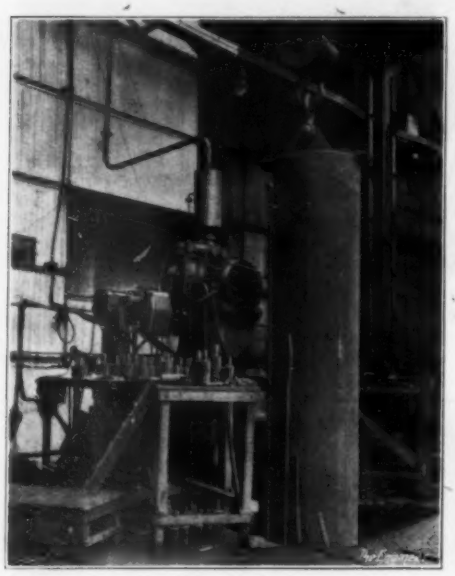


FIG. 7—130-TON HYDRAULIC RIVETTER.

fittings are put into place, and the drums tested. Before caulking the drums internally they are, we were informed, always about 95 per cent. tight, and when the ends are turned and shrunk on, the test generally shows that the drum is "drop dry" before riveting, bearing testimony to the accuracy ofworkmanship and machining.

We saw in course of completion boilers of the industrial and marine pattern destined for nearly every part of the world, and including both riveted and solid forged steel drums.

A NEW CHAIN GRATE STOKER.

We describe in what follows a new type of chain grate stoker which has been specially designed for high-duty forced-draught conditions, and can be made in standard widths up to 30ft.

As will be seen from Fig. 10, on page 632, the stoker is enclosed at the front, but arrangements are made whereby it can be opened and operated under natural draught at lower rates of combustion. In the model we saw in operation, the travelling grate was 9ft. by 20ft. and was driven

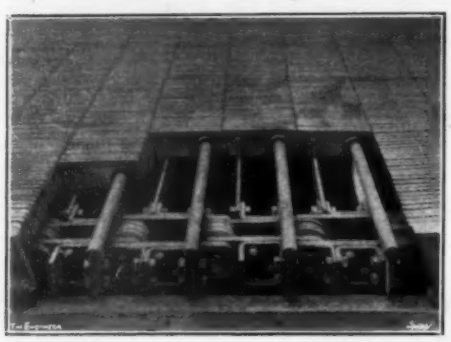


FIG. 8—ARRANGEMENT OF LINKS

by a 2 B.H.P. motor. As our illustrations show, particularly Figs. 8 and 9, the grate is composed of cast iron links of the drop type, which are threaded upon bulb bars. These bars are carried by cleats, which are attached to mild steel driving chains. The pins of the chain carry V wheels, which, at the top of the grate, run on rails and at the bottom are supported upon skid bars, arranged upon bearers.

Special metal is used for the grate links, and the design is such that an even air distribution is assured, while the spacing gives the minimum amount of riddlings. As will be seen in Fig. 11, the sides of the grate are flush and so form an effective seal. A scraping link is provided on each side of the grate to prevent clinker growth from taking place. When water walls are fitted, this attachment is not required.

The supply of air is directed from underneath in a direction parallel to the travel of the grate within the furnace. There are under-compartments with dampers at the front and rear to enable the supply of air to the grate to be regulated. The regulating levers are operated from the outside of the side frames. The very fine riddlings which may pass through the grate links into the compartments below are discharged through a narrow slot at the bottom of each compartment, and drop on to the underside of the grate, on which they are carried along and deposited in the riddling pit. As shown in Fig. 9, the alternate links at the end of the grate work with a scissors action, which renders them self-cleaning. Any clinker passes over a dump bar and may be discharged by the dumping lever.

The front of the furnace is clearly shown in Figs. 10 and 11, which illustrate the coal hopper, fire door and fuel valve. The valve is in the form of a segment of a circle, and when fully opened it seals the front of the grate. When it is desired to work the stoker under banked fire and lighting up conditions, the coal valve can be raised by gearing to a suitable height of open front.

At the return end the grate passes over cam-shaped castings, which eliminates the rear driving shaft and rear bushes, so avoiding the lubricating difficulties which have often been experienced with such shafts. The grate

FIG. 9—LINKS AT GRATE END

tensioning arrangement is of the firm's standard pattern, there being three front bushes with stretching screws fitted into slots in the front of the frame.

Several examples of the new type of stoker were seen going through the shops, the first of which will be installed at Wolverhampton.

The members of the party also inspected the structural shops, where many cranes were seen in course of completion, and also viewed the very extensive machine shops and pipe bending and welding departments, and the well-equipped foundry.

American Engineering News.

Oil-electric Shunting Locomotive.

A DOUBLE-UNIT locomotive of 660 horse-power for shunting service on the Long Island Railroad consists of two four-wheel units, each equipped with a 330 horse-power oil engine, generator, motors and auxiliaries. Normally they are coupled together as an 0–4–4–0 engine, but they are capable of being detached and operated independently. The total weight of the double unit is about 85 tons. Each oil engine is a vertical six-cylinder four stroke cycle airless injection motor, weighing only 7000 lb. and having a speed range from 300 to 800 revolutions. The main generator, bolted to the engine fly-wheel, is a 750-volt, 210-kW machine, which serves to start the oil engine, taking its power from a storage battery, and to charge the battery and operate the compressors when the engine is run at idling speed. At higher engine speeds the generator supplies current to two motors. An auxiliary generator operates the compressors and charges the battery when the main generator is supplying power to the motors. Each unit has a fuel oil tank of 210 gallons capacity. With a gear ratio of 16 to 66 and wheels 38in. in diameter the maximum speed is 34 miles an hour. The maximum tractive effort is 49,000 lb. The length overall is 50ft., with a total wheel base of 33ft. 4in. and a rigid wheel base of 9ft. 6in. for each unit.

A Central Diesel Power Plant.

To supply power to its scattered group of zinc mines and mills in Oklahoma, the Commerce Mining Company has a central station equipped with three Diesel engines of 2250 H.P., each driving a 1500-kW generator. Space is provided for a fourth unit. This station supplies power to eighteen mines and mills, to a central air compressor station which also serves these plants, to the city of Miami, and for the company's railway, 55 miles long. The Nordberg-Diesel engines have four cylinders, 28in. by 44in., and are of the two-cycle type, with fuel injection by compressed air. The three engines are in operation during the eight-hour period of heavy load, but at night only one is in service. Besides the chief engineer, there is an engineer and an oiler on each eight-hour shift. Of the 33,000-volt transmission lines from the station to the mines and the railway, the longest are 15 and 10¼ miles. Fuel oil delivered in railway tank wagons is stored in two tanks of 10,000 barrels capacity, and one of 15,000 gallons, this last being for light oil. The engines use a heavy oil of 14 deg. to 16 deg. Baumé. Gravity lubrication is used throughout, except for the engine cylinders, the used oil being delivered to filters and returned to the storage tanks of the lubricating system. The central compressed air plant, adjacent to the power station has three horizontal two-stage compressors, with a capacity of 2200 cubic feet per minute, each driven by a synchronous motor of 365 H.P. The 28in. suction and discharge pipes are of welded steel. Reinforced concrete chambers are built for the exhaust mufflers and air filters.

Wood Preservation in America.

The wood-preserving industry in the United States is growing steadily, owing to the increasing use of treated timber for various purposes. Creosoting is practically universal with zinc-chloride declining, and about 60 per cent. of the creosote is of domestic manufacture, the remainder being imported. There are now 187 treating plants, of which 117 are for the pressure system and 56 for open-tank treatment, while 14 operate both systems. The quantity of timber treated in 1927 was the largest on record, 345,685,804 cubic feet; while the amount of creosote was also the largest, 219,778,430 gallons. Although 22,162,718 lb. of solid zinc-chloride was used, this was less than in 1926, and there has been a steady decline for some years. It is interesting to note that 22,911,134 gallons of petroleum were used for diluting creosote, this mixture being used mainly for railway sleepers, since the more expensive all-creosote treatment is often unnecessary for the practicable life of sleepers, which are subject to wear as well as decay. Railway sleepers represented 64 per cent. of all the wood treated. Their number was 74,231,840—again a high record. Of these, 80 per cent. were treated with creosote or a creosote-petroleum mixture. About 10,800,000 were treated with zinc-chloride, and 3,700,000 with zinc-creosote. Piles, aggregating 17,240,000 lineal feet, were treated, mainly with creosote. Poles numbered 3,637,989. Wood paving blocks for 2,008,160 square yards were treated, but mainly for indoor paving, and most of them were treated with a special grade of oil.

Burning Coal in Suspension.

A method of using coal in large boiler furnaces is to crush it to about ¼in. size—not pulverise it—and blow it by compressed air downward into the furnace, where a vertical air blast blows it up and keeps it in suspension while burning. This blast supplies sufficient air to burn the finer particles at once, the same as with pulverised coal. The larger particles are practically consumed before falling upon a small reciprocating grate. The forward movement of the grate brings the bed of coke and ash over a slot above the ashpit. An upward blast of air blows the light coke particles up into the heated zone of the furnace, while the heavier ashes fall through the slot into the pit. The lower part of the furnace is an inverted pyramid, with the grate at the bottom or apex. Above the body of the furnace is the water-tube boiler. One plant using this system has three boilers, each with 5100 square feet of heating surface and designed to burn 5000 lb. of crushed coal per hour. The velocity of air at the jet is 2530ft. per minute, and reduces in the large volume of furnace space. The ash is granular, with little dust, and averages only 10 per cent. of combustible content. The arrangement is such as to cause a turbulent condition of the gases and fuel in the furnace, which contributes to complete combustion. The purpose of the design of this furnace is to reduce the cost and power for crushing and preparing the coal. It is built by the Stratton Furnace Company, of Chicago.

Railway Electrification in America.

The latest step in electrification of railways in America is the adoption of the 3000-volt direct-current system for the suburban lines of the Delaware, Lackawanna and Western Railroad, tributary to the New York city district. This same system will be used also for a heavy traffic mountain division of the same line. The only other usage of this voltage is on the main line of the Chicago, Milwaukee, St. Paul and Pacific Railway for 440 miles in the Rocky Mountains, but it has been decided to adopt it for the new joint line and station at Cleveland. The Butte, Anaconda and Pacific Railway, 45 miles, uses 2400 volts. The terminal and suburban lines of the Pennsylvania Railroad and the New York Central Railroad at New York both use 600 volt direct current, with third rails, but the Pennsylvania system provides for a future 11,000-volt alternating current with overhead trolley wire, and the New York Central is reported as contemplating a change to 3000-volt direct current when extensions are made for electrification. The Michigan Central Railroad uses 600 volts for its tunnel line and terminus at Detroit, while the Illinois Central Railroad uses 1500 volts for its Chicago suburban service. The Long Island Railroad uses 650-volt direct current on its suburban lines, but 11,000-volt alternating current on a goods line and terminus. All railways using alternating current have adopted 11,000 volts, although two lines have proposed 22,000 volts. These railways include the Boston and Maine, the Detroit, Toledo and Ironton, the Great Northern, the Norfolk and Western, the Pennsylvania, the New York, New Haven, and Hartford, and the Virginian. In all these cases the electrification is on main lines with heavy traffic and steep gradients.

THE WICK ELECTRICITY SUPPLY.—In the article on the Wick Electricity Supply appearing in our last issue we omitted to mention that the 132 horse-power engine was manufactured by Ruston and Hornsby, Ltd., of Lincoln.

THE JUNIOR INSTITUTION OF ENGINEERS.—At an informal meeting held on November 30th, Mr. C. W. Harvey gave some interesting particulars of the process of "Manufacture of Decorative Metal Work," such as electric light fittings, door furniture, decorative lanterns and works of art in metal generally. Commencing with a description of the *cire perdue* process of casting figures, &c., he explained how by this means the actual handiwork of the designer or artist was exerted on the wax model from which the finest lines could be reproduced in the casting, thus avoiding very little work in the finishing process; but as the method involved the destruction of the model and mould it was a costly process not suitable for the reproduction of a number of similar pieces. The usual method was to employ the ordinary two part sand mould. The most important operation on the brass casting thus produced was the work of the graver, who removed all fins and mould marks and deepened and sharpened up the incised portions of the casting. It was essential that the metal used should be of good quality if the work of the graver was to be satisfactory. This work was necessarily done by hand, and mass production methods could not be applied. The various finishes for art metal work included gilding by electro-deposition and subsequent burnishing of the high lights; mercurial gilding in which the most important item was the heating of the article after coating with the amalgam to drive off the mercury and leave an even coating of gold; and gold leaf plating. Lacquering was a preservative, and in conjunction with turpentine and burnt sienna was also used to tone and colour work, the latter mixture after being left for a few minutes, being brushed off with a glass-haired brush giving a soft antique finish to the metal. Silver articles were oxidised by immersion in a solution of potassium sulphide which formed a dark surface, the high lights being gently cleaned with damp pumice powder and the article subsequently lacquered.

Railway Matters.

THE Tooting Broadway Station on the Morden extension of the City and South London Railway was opened only two years ago. It now serves 800,000 passengers a month, and so is the second busiest station—exclusive of exchange stations—on the "Underground" system. A third escalator has now been erected in it.

ALL four grouped companies have each deposited a Bill for the 1929 session to enable them to provide, own, work and use aircraft and to convey therein traffic of any description; to establish and use aerodromes; to enter into agreements with any company, body or person in relation thereto, and to apply their funds to air transport purposes.

THE nominations of the Council of the Institution of Railway Signal Engineers for the officers in 1929–30 include Mr. R. G. Berry, as president, and Mr. W. Wood, as vice-president. Mr. Berry is the signal assistant for the Northern Division, London, Midland and Scottish Railway, and Mr. Wood is the electrical engineer for Scotland, London and North-Eastern Railway.

IT is not often that railway companies now carry claims for compensation for personal injury, arising out of accidents, into court, but the Southern Railway has felt it necessary to do so with a case resulting from the Sevenoaks accident. The Press reports do not say what amount was claimed. The company admitted its liability, but alleged that the plaintiff had not been injured as he stated. The jury awarded £900, which was less than the sum—£1000—the company had paid into court.

THE Departmental Committee on mineral transport was set up as one of the results of the Samuel report during the coal stoppage of 1926, and on November 13th the Minister of Transport was asked whether it had yet issued a report or made any recommendations. Colonel Wilfrid Ashley, in reply, said that the Committee was not at present in a position to put forward any definite recommendations, as it had been found necessary to make detailed investigations into the existing facilities, the present user of wagons and other matters affecting its reference. It was not likely to report until the earlier part of next year.

THE Canadian National and Canadian Pacific Railways have placed large orders for rolling stock equipment, which was urgently required owing to the building of numerous extensions during the year and the increase in traffic. Orders for cars have been distributed between three companies:—The Canadian Car and Foundry Company, of Montreal; the National Steel Car Company, of Hamilton, Ont.; and the Eastern Car Company, of New Glasgow, N.S. The value of the orders placed by the Canadian National is estimated at approximately 14,000,000 dollars, and the orders placed by the Canadian Pacific, though not so large, are expected to be shortly followed by others.

AN interesting announcement was officially made by the London, Midland and Scottish Railway on Friday, November 30th. Mr. S. H. Hunt, who had been with the London and North-Western since 1880 and eventually became its chief goods manager and, later, one of the vice-presidents of the London, Midland and Scottish, retires at the end of the year. He is to be succeeded by Mr. F. G. Evans, the secretary to the company, who is one of the highest authorities on railway finance. Mr. Glynne Roberts, who now ranks as assistant to the president and superintendent of the central office, will be the secretary to the company, but will continue to act in his present capacity.

THE new general manager of the United Railways of the Havana and Regla Warehouses, Cuba, is to be Mr. Lightly Simpson, now the chief mechanical engineer of the Cordoba Central. Mr. Simpson is an old Stratfordian and the grandson of one of the chairmen of the former Great Eastern Railway. He went to the Buenos Aires Pacific in 1907 and was released in 1915 for active service. Eventually Mr. Simpson became the chief mechanical engineer in charge of all works and rolling stock used by the British forces in France and Italy, and on the formation of the Ministry of Transport was the Chief Mechanical Engineer to that Department. In 1924 he took up the position on the Cordoba Central from which he now retires.

THE motoring contributor of our contemporary, *Truth*, in the issue of that paper for November 21st, has some notes under the heading "Dangerous Level Crossings," which criticise the delay in substituting bridges for level crossings. He winds up by saying that "meanwhile the number of accidents at level crossings is increasing," and adds that 42 persons were killed in that way last year. An analysis of those accidents, as given in Sir John Pringle's annual report, shows that 33 of the fatalities occurred to pedestrians, and 19 of the 33 were at footpath crossings and 8 at occupation crossings. Only 8 persons were killed at public road crossings, 6 of them were pedestrians, and one was the crossing-keeper. All the accidents were classed as due to a lack of proper caution.

ON July 2nd last a goods train of twenty-nine four-wheeled wagons and a 20-ton brake, of a total weight of 298 tons, drawn by an 0–6–0 tender engine, was descending the heavy gradient—of 1 in 80, 1 in 67, 1 in 70, and 1 in 67 again for 8 miles—into Pinwherry Station on the Stranraer and Girvan section of the London, Midland and Scottish Railway, when it was derailed on the sharp curve at the outgoing end of the station. The driver and fireman were killed. The accident was inquired into by Colonel Trench, whose report thereon has recently been issued. No defect in the engine, train or track could be found, and it was the conclusion of that officer that the cause was a speed of about 50 miles per hour over curves which were suitable for low speed only. A point to be remembered is that after passing through Pinwherry the line rises for 3¼ miles on gradients of 1 in 100, 1 in 65, and 1 in 69, and it seems possible that the driver, who "was not intimately acquainted with the road by long experience," wishing to make a good run up the severe gradient beyond Pinwherry, was running to higher than booked speeds, and that he forgot the severe curvature and the speed restriction of 15 miles per hour through the station.

Notes and Memoranda.

WHAT is claimed to be the largest cofferdam ever constructed is now being built in connection with the development of St. John Harbour, New Brunswick. It is 4300ft. long by some 300ft. wide, and is to embrace one of the two new piers which are contemplated.

IN the November issue of the *Indian Concrete Journal* there is a description of the pontoon road bridge over the Kamla River, which comprises eight reinforced concrete pontoons carrying a timber bridge about 180ft. long. It is noteworthy on account of the fact that it survived a recent flood which did considerable damage to an adjacent iron bridge.

THE latest "paper" issued by the Safety in Mines Research Board—it is numbered 47—deals with the pyritic oxidation of coal with special reference to the Ravine Seam of Lancashire. It is not, however, specially concerned with the cause of spontaneous combustion in that seam, but deals in a general manner with pyrites and its oxidation. The paper can be obtained from H.M. Stationery Office, price 1s. 6d.

ACCORDING to *Indian Engineering*, it is probable that there will be a big increase in the use of motors in Ipoh in the near future, as a result of the opening up by the Perak Hydro-electric Company of one of their own stations within the next two or three months. The motors, that journal states, will, of course, be used for driving gravel pumps in tin mines, and the usual equipment is a motor between 45–180 H.P. with controller.

ALTHOUGH American manufacturers for many years showed comparatively little interest in the development of the mercury arc rectifier for power applications, conditions have changed recently, and this equipment is slowly but surely finding its place in the American railway sub-station. It is significant, states the *Electrical World*, that the companies which have had rectifiers in operation for some time give every indication of being quite satisfied with the service and of their intention to install additional rectifiers in future sub-stations.

AN indication of the market for agricultural machinery which is represented by the northern territories of Canada is given by the following sentences from an article in *Canada*: "Twenty-five years ago no less an authority than the Chief Naturalist for the Canadaian Government stated before a Committee of the Canadian Parliament that the Peace River country, in the province of Alberta, would never be suitable for growing wheat or mixed farming. But in this year of grace 1928 that same Peace River country has produced an exportable surplus of wheat estimated at approximately 5,000,000 bushels, or almost as much as the exportable wheat surplus of all Canada in 1900.

AN investigation carried out by the Pittsburg Experiment Station reveals that, while permissible miners' flame safety lamps when correctly assembled and intact will not ignite mixtures of petrol vapour and air, these lamps are not suitable for determination of inflammable vapour content of the atmospheres in and around tanks. The lamps will give unmistakable evidence of the presence of an explosive mixture, and will give satisfactory indications to a trained observer in vapour percentages of approximately half of the lower explosive limit. Below this limit the lamps decrease in value as detectors, and at 0·3 per cent. and lower the evidence is so small and difficult to observe that it should not be depended upon.

THE production of silica and magnesia crucibles in the induction furnace has been achieved in the laboratory of the Pacific Experiment Station of the Bureau of Mines, Berkeley, California. The essential new parts of this work are the development of a technique for the high-frequency furnace production of silica crucibles of greater wall thickness than could be readily fabricated from commercial fused silica, and for heavy walled magnesia crucibles of great density and mechanical strength. A description of the method employed, which produced crucibles of excellent quality in a reasonable time, and with a moderate expenditure of power and materials, is given in Serial 2896, by C. N. Schuette, published by the Bureau of Mines.

AN interesting paper was recently contributed to the South African Institution of Engineers by Mr. C. D. H. Braine on the subject of soil erosion and its prevention, which is very forcibly exemplified in the production of "dongas" in that country. Dongas are what might be described as accidental watercourses, and the author says that it may be taken as almost a fixed rule that donga reclamation should begin at the top end, as one great thing is to prevent the donga cutting any further back. Low barriers should be erected at intervals in the bed of the channel. The distance apart largely depends on the gradient. The barriers, if possible, should be arranged to pass the flood water and collect as much silt and drift as possible. It is a good thing to place them so that the silt collected behind one barrier extends to the toe of the one above.

A NEW kind of machine tool material, known as Carboloy, and composed of tungsten carbide and cobalt, was, says the *Engineering News-Record*, announced by Dr. Samuel L. Hoyt, of the research laboratory of the General Electric Company, at the annual Convention of the American Society for Steel Treating at Philadelphia, on October 11th. The carbide is extremely hard, and the cobalt gives the material the necessary strength for use in cutting tools. According to Dr. Hoyt, "the new material can machine harder and denser grades of steel than can be handled economically by high-speed steel; and steels with higher alloy contents than are now commercially machinable will be brought into the machinable class." It is particularly applicable to the field of weak or low tensile materials, which are also uncommonly abrasive to present tools. It is claimed to be particularly applicable for drilling holes in concrete and rock, in which service it is claimed that Carboloy is less expensive than diamond drills and cuts a smoother hole than the hammer drill. Cast iron castings can also be cut easily with the new material. On the Brinell scale, Carboloy shows a hardness of 2000 and above, as compared with an average maximum hardness of 850 for common tool steel and about 1000 for the hardest steel.

Miscellanea.

IT is proposed to double the track of the Shanghai-Nanking Railway.

A PLANT for the manufacture of carbon dioxide gas is to be put up at Montreal.

THE new road bridge across the river Torridge, near Bideford, was opened on the 5th inst.

A FACTORY for making motor car brake lining material is being organised at St. John's, Quebec.

THE output of rolling stock from the plants of Ontario during last year was valued at about 74,500,000 dollars.

A SCHEME of harbour development, which is to cost 1,250,000 dollars, has just been started at Collingwood, Ontario.

THE steel lock gates required for the new dock at Bromborough of Lever Bros. are to be supplied by Vickers-Armstrongs, Ltd.

WHAT is claimed to be the world's largest grain elevator has just been set to work at Port Arthur, Canada. It has a capacity of 7,200,000 bushels.

THE new aluminium works of the Società Italiana dell' Aluminio have a capacity of from 5000 to 6000 tons a year, and a new plant is to be started very soon.

IMPORTANT deposits of antimony have been discovered near Wolfersgrun, a small village in Upper Bavaria. An antimony content of 29 per cent. is reported.

A COLD storage plant is to be put up at Ogden Point, Victoria, British Columbia, at a cost of 550,000 dollars. The equipment alone will cost some 150,000 dollars.

SOME shops for "the manufacture of tubes by a new process" are, it is said, being erected at the Coombs Wood Tube Works, Halesowen, of Stewarts and Lloyds.

ACCORDING to the latest reports, the number of overseas buyers who have promised to attend the next British Industries Fair will be at least three times as great as those of the last Fair.

ARRANGEMENTS have been made by an English company for the development of the iron mining industry of Minas Geraes, Brazil. The intended output is three million tons a year, and the scheme includes the reconstruction of the railway to Santa Cruz.

ARRANGEMENTS have now been completed whereby the London Chamber of Commerce will undertake the educational examination of candidates for entry to the service of the Port of London Authority, and the examinations for promotion of those already in the service.

THE Anconda American Brass Company, which for the past six years has, according to the *Ironmonger*, occupied the Brown Copper and Brass Rolling Mills at New Toronto, has purchased the property and 12 acres adjoining, and is planning considerable extensions to the plant.

A TUG and salvage vessel just launched at Willington Quay by Sir W. G. Armstrong, Whitworth and Co. for the South African Railways and Harbour Administration is claimed to be the most powerful of her type ever built. She is of the twin-screw type and has engines of 3500 horse-power.

IT has been decided to found at Sheffield University an Ironmongers' Company Research Fellowship and two Ironmongers' Company Research Scholarships for the study of the cold working of metals, for which purpose a grant of £800 per annum for seven years is to be made to the University.

THERE are 603,760 telephones in use in the London area, according to figures just published by the Post Office. This figure marks an increase of 46,300 for the year. The one hundred and thirtieth telephone exchange is now in operation in London, whilst thirty-seven additional centres are under construction.

ACCORDING to the *Daily Telegraph*, the Soviet Inventions Bureau has granted patent rights to a Roslavl wireless engineer named Zlotnikov in respect of his invention of a so-called "master wireless clock," which, it is claimed, will keep any number of specially adapted clocks and even watches going and synchronised.

A NOTE from the United States Department of Commerce states that rapid progress is being made in the construction of the plant for the recovery of helium gas at Soncy. The natural gas from which the helium is to be extracted will come from the wells of the Amarillo Company, which have an open flow of 27 million cubic feet a day.

ACCORDING to a report from S. C. Chen, head of the Bureau of Constructive Works, Kiangsu Province of China, the new constructions of the province during this year are building and repairing of the stone sea walls, dredging of rivers and canals, building of highways, extending of telegraph and telephone lines, and removing of the provincial capital from Nanking to Chinkiang.

THE Westminster City Council proposes to expend £91,000 on the improvement of the Grosvenor Canal. The scheme includes widening the dock entrance under Chelsea Embankment; the construction of a new dock and swing bridge; reforming the canal basin and reclaiming parts of the site of the old canal. The proposed works are intended to increase the facilities for loading and unloading waterborne material, used by the Council, to increase the efficiency of the depôt service, and to set free a large site for a housing scheme and health centre.

A COMMITTEE appointed by the Radio Manufacturers' Association of the United States recommends that all radiovision pictures at present being broadcast be standardised, so that one radiovision receiver with one scanning disc will be able to receive any of them. The committee adopts as standard the system used by C. F. Jenkins in Washington. The method recommended uses forty-eight lines with fifteen separate pictures (frames) every second. The pictures therefore will not show much detail, being decidedly inferior in this respect to the pictures which J. L. Baird can broadcast from his laboratory. It is expected that all the television broadcast stations in the United States will adopt this standard, so that one receiver with one scanning disc will be able to receive any of them.

BOILER MANUFACTURING PLANT AND A NEW CHAIN GRATE STOKER

BABCOCK AND WILCOX, LTD., RENFREW, ENGINEERS

(For description see page 628)

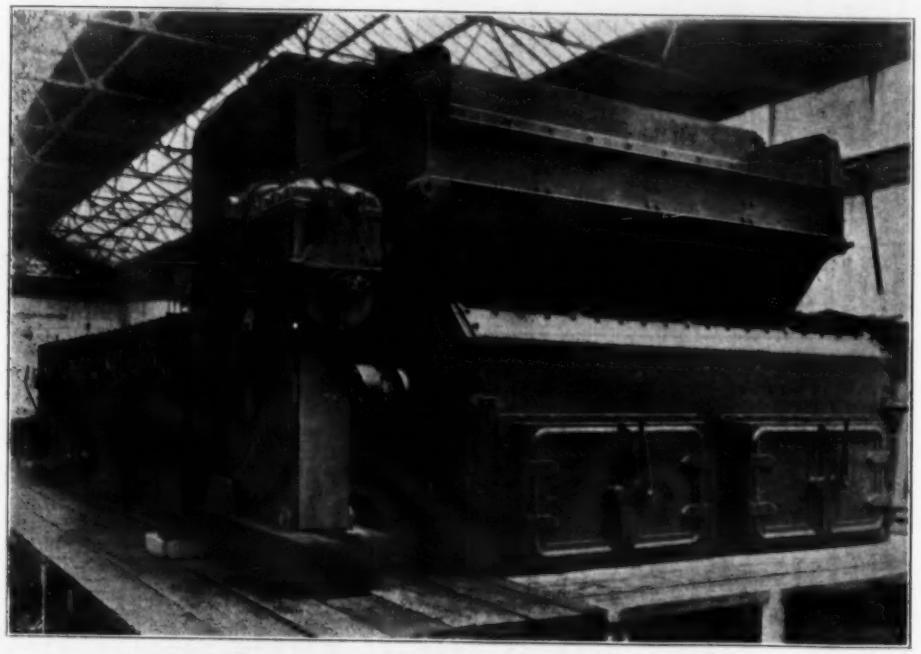


FIG. 10—NEW STOKER—COAL AND ASH-PIT DOORS CLOSED

FIG. 11—NEW STOKER—COAL AND ASH-PIT DOORS OPEN

FIG. 12—EIGHT-SPINDLE DRILLING MACHINE FOR BUTT STRAPS

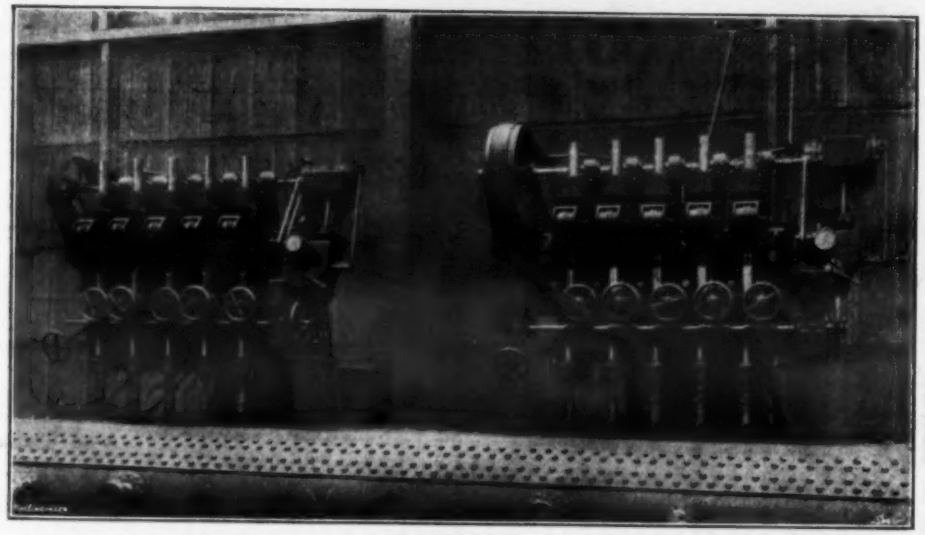


FIG. 13—TEN-SPINDLE DRILLING MACHINE FOR TUBE HOLES

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THE ENGINEER.

DECEMBER 7, 1928.

The American Cruiser Programme.

THE United States naval building programme which failed to pass through Congress last May is to be re-introduced during the present session. There is very little doubt that it will be approved by a substantial majority. The Bill provides for the construction of fifteen cruisers at the rate of five a year from 1929 onward, and one aircraft carrier. The cruisers are to be of uniform type, with a standard displacement of 10,000 tons and a main armament of 8in. guns, the Navy Department having decided that smaller ships are unsuited to American requirements. Each cruiser is estimated to cost £3,400,000, or nearly 75 per cent. more than a British "County" ship of equal tonnage. The aircraft carrier represents a new design, and will not exceed 13,200 tons, in contrast with the 33,000 tons of the "Lexington" and "Saratoga," which American naval officers consider too large, vulnerable, and expensive to be worth repeating.

That the fate of the new programme will be watched with interest in this country goes without saying. In one sense, no doubt, it is competitive, since its avowed purpose is to bring the United States Navy nearer to the goal of "parity" with the naval forces of the British Empire. We are sure, however, that no intelligent person on this side of the Atlantic credits the American Government or people with aggressive designs. When reviewing American naval policy it is essential to bear in mind certain facts which are too often overlooked. In the first place, the American claim to co-equality in sea power is not of recent origin. As far back as 1912 it was advanced as a fundamental principle of national policy to which expression was given in the naval programme of that year, and again in the preamble to the great building scheme of 1916. In the second place, this principle formed the groundwork of the American proposals at the Washington Conference, when it was formally accepted without demur, qualification, or reserve by the British delegates on behalf of their Government. Since then successive British Prime Ministers and other Cabinet members have declared that our Navy is henceforth to be maintained at a one-Power standard—that is to say, its strength is to be neither greater nor less than that of the United States Navy. In view of these acknowledged facts we have no cause to reproach the United States if they now propose to make up a patent deficit in a very important category of naval tonnage. For the unfortunate controversy which has momentarily clouded Anglo-American relations neither party is free from blame. Ill-considered speeches made in this country by public men who apparently were ignorant of the facts we have recited have given offence in the United States, while the propaganda of American "big-Navy" enthusiasts has had similar reactions here. This mutual misunderstanding became more pronounced after the failure of last year's conference at Geneva. The conference afforded a golden opportunity of settling the one and only serious political difference that exists between the two countries. But the importance of the occasion was not appreciated. Both parties laid too much emphasis on technical side issues, and eventually the conference broke down for want of that statesmanlike guidance which had characterised the proceedings at Washington six years before. That the failure to reach an agreement still rankles in American minds is made clear by President Coolidge's outspoken address on Armistice Day. Still more significant was the naval programme announced in December, 1927, six months after the Geneva conference. It called for the building of no less than seventy-one vessels, and although ostensibly designed to give the United States a navy "second to none," it would, in fact, have given her actual primacy afloat. Twenty-five cruisers of the largest type were demanded, together with nine flotilla leaders, thirty-two submarines, and five aircraft carriers. Added to the existing establishment—which included eighteen heavy cruisers built or building—these ships would have raised the United States Navy to commanding rank. But the scheme was too ambitious and its motive too obvious to commend itself to the American nation. In deference to public opinion it had to be cut down ruthlessly. The twenty-five cruisers were reduced to fifteen, the five aircraft carriers to one, the destroyer leaders and submarines were scrapped *en bloc*. The programme as it now stands is not, in our judgment, excessive in scope or aggressive in intent. Its completion will still leave the United States short of the quota of cruiser tonnage to which they are entitled under the fifty-fifty ratio, though it will give them superiority in the largest and most heavily armed type of cruiser. If the programme is enacted and duly carried out, twenty-three American cruisers of the 10,000-ton, 8in. gun type will be ready by 1934. By the same date the British Empire should have fourteen cruisers of 10,000 tons and six of 8400 tons, all mounting 8in. guns. If the four older "Hawkins" ships—9750 tons, with a 7·5in. armament—are included, our total of heavy cruisers will be twenty-four, but in modernity, aggregate tonnage, gun power, and speed the American heavy cruiser fleet will enjoy a distinct advantage. We draw this comparison for no other reason than to show that the new programme will bring the United States appreciably nearer to "parity" than some of her naval propagandists are willing to admit. To these twenty-three very large cruisers must be added the ten ships of 7500 tons, "Omaha" class, which were laid down after the war and finished in 1923–25. With a sea speed of 33 knots the formidable armament of twelve 6in. guns, and a wide radius of action, they are ships that come well within the ocean-going category. The only comparable vessels in the British Navy are the "Emerald" and "Enterprise." Accepting the dictum of the Washington Navy Department that the future lies with big cruisers of powerful armament and great steaming endurance, we arrive at the following figures, based on the American programme *in petto* and the British programme *in esse* :—United States, thirty-three ships ; British Empire, twenty-six ships. There remains the mass of British "light" cruisers which have no counterpart in the United States Navy. Of these we possess about thirty-three. While it would be absurd to write them off as valueless, it would be equally absurd to class them as equal in any respect to the heavy cruisers we have been considering. As they will never be replaced, they represent a diminishing asset. Owing to age and the rigours of war service many are already ripe for the scrap heap, and the total disappearance of these small, obsolescent ships is only a matter of years.

It would be a complete mistake to assume that the Anglo-American naval problem hinges on the

question of cruiser tonnage. The real issue lies much deeper. The foreign trade of the United States has grown enormously in the past decade, and now represents a vital factor in the economic life of the Republic. During that period of the war in which America remained neutral her trade suffered severely, if inevitably, from the restrictions imposed by the Allied blockade. Hence arose the demand for "freedom of the seas"—in other words, the immunity of neutral shipping from interference—which constituted one of President Wilson's "fourteen points." Pending a new codification of international rules on this subject, America believes that her interests as a neutral in time of war will best be conserved by a fleet inferior to none in magnitude. This is unquestionably the principal motive governing her post-war naval policy. Meanwhile we in this country must resolutely face the new situation that has developed since the war. It is clear that we should not be in a position to maintain a supreme fleet in the teeth of American competition. But, in fact, we have accepted America's claim to an equal share in the control of the seas, and having done so it would be unreasonable to grumble now that she shows signs of implementing that claim. Thanks to her immeasurably superior resources, it would be well within her power, not merely to build up to our level in cruisers, but to outbuild us in any and every type of fighting ship. For our part, however, we unhesitatingly accept the assurances from Washington that the ultimate aim of American naval policy is equality and not supremacy. We are therefore unable to perceive any cause for uneasiness in the new building programme.

Automatic Train Control.

IT is a great relief that the driver of the mail train concerned in the Charfield disaster of October 13th has been acquitted of the charge of manslaughter. Railway people—officers and men—of every degree will welcome the decision, as a contrary one would have brought discredit upon their name. Moreover, such an event as finding a railway servant criminally responsible for a railway accident is most rare. During the last five and twenty years there have been only three such cases—driver Gourlay after the Elliot Junction accident of December, 1906; driver Caudle in the Ais Gill collision of September, 1913; and the two signalmen concerned in the Quintinshill disaster of May, 1915. It, perhaps, ought to be recorded that the former two men had their sentences reduced, and that, further, Caudle was taken back by his old company. It must be admitted that in the Charfield case criminal proceedings appeared to be warranted. The fact that the goods train was shunting implied that, because of the interlocking, the home signal was at "danger," and that, as a consequence, the distant or warning signal was "on." The driver, however, claimed that the latter signal was "off," and whilst, presumably, it was not, there was nothing to prove that he was wrong. It could not, for instance, be said that the signal was found in good order after the accident; in fact, the exact opposite was the case, owing, it is safe to say, to wreckage on the signal wire pulling the arm from its horizontal position. There was also a difference of opinion as to the existence of fog, and, if so, as to its density. As, however, the driver did not claim that, owing to fog he could not see the distant signal, that point is not of prime importance.

The matter must now rest until the report of Colonel Sir John Pringle is issued. Meanwhile, all criminal proceedings being at an end, it would appear to be desirable to consider whether all that is possible is done to assist a driver in his responsible work. But before we deal with that point there are certain aspects of the distant signal question which must be mentioned. According to the evidence, as reported in the newspapers, the distant signal at Charfield was 1480 yards from its lever in the signal-box. That is nearly double the distance generally adopted until railway companies introduced outer home signals, and is a long length to be actuated by a single wire. It is questionable whether all such signals should not be operated electrically—as is done in many instances—or worked by an outward and a return wire. Another practice which would prevent doubtful distant signals is what is known as "proving the signal." Where it is adopted the block telegraph wire is led through the electrical repeater on the signal arm, and "line clear" cannot be sent unless the distant is fully "on." These are solutions which not only exist, but are fairly widely adopted, and, having mentioned them, we may now consider what can be done to help the driver in his work. A great deal has, during the last thirty years, been done for signalmen—they have electrical repeaters for the signals, adjusters for the wires, illuminated diagrams in many cases, track circuits for trains and vehicles standing out of their sight, and on many sections lock-and-block. Drivers have not had the same generous consideration given to them, except in the way—a most important respect, it is true—of selecting the best possible positions and heights of signals. On the other hand, the larger boiler and the short funnel tend to obscure the running view. Nothing, except on the Great Western, has been done to advise drivers of the condition of signals in foggy weather nor to warn them that they are approaching or passing an adverse distant signal which, for some reason or other, they may miss. Obviously, then, the Charfield accident has again brought into prominence the dual question of the automatic control of trains when "danger" signals are exhibited and of warning drivers of the condition of distant signals. That is a question which is now being discussed by a Departmental Committee. In THE ENGINEER of January 27th last we discussed the purpose of that Committee, and all that need now be said is that its terms of reference are, mainly, to review the recommendations of a Committee which considered this question between October, 1920, and April, 1922, such review being necessary because, first, the ramp system previously recommended has been abandoned in the United States, and, secondly, because of the necessity to secure uniformity in clearances. The earlier Committee reported that automatic train control was practicable and was necessary. Since then, however, the annual reports each year of Sir John Pringle have remarked that the number of accidents did not justify immediate action in the adoption of automatic train control.

The present year has not, it must be pointed out, brought any increase in the number of accidents; it is their seriousness that has increased. In view of that fact and of the financial condition of the companies, it does not seem that the compulsory adoption of train control would be justified at this time. But for reasons advanced above some assistance for drivers appears to be necessary. Towards that end, then, we venture to suggest that without going to the expense of equipping automatic train control—which means expensive electrical methods, possibly continuous track circuit, and refinements in maintenance on locomotives and track—a simple cab signal system be adopted that would repeat on the footplate the condition of all distant signals. That would not, we admit, meet those cases where trains starting from dead, or shunting, pass signals at "danger," but in all such instances the speed is low. It would, however, assist the driver when running at speed, and that is not only the greater but the more frequent need. Such a cab signal system might, we conceive, be so designed that the automatic train control equipment could, if necessary, be added later. It must be remembered that fog signalling costs £100,000 a year, and that sum would be saved by cab signals.

Literature.

Enamels: Their Manufacture and Application to Iron and Steel Ware. By LAURENCE R. MERNAGH, B.Sc., F.I.C., A.C.G.F.C., F.C.S. London: Chas. Griffin and Co., Ltd. 1928. Price 18s.

IN his preface the author deprecates the attitude of the enamelling industry of Great Britain towards scientific control; not only has the enameller a mighty contempt for any but the "practical" man, but he has an equal contempt for any other "practical" man than himself. It is pointed out that such an outlook cannot possibly lead to similar progress being made in this country to that in Germany, America and elsewhere. There, the old-fashioned trade secrecy is dying out and enamellers are pooling their knowledge to their mutual benefit. While accepting the advances made by science in the realms of colours and of steel, the English manufacturer of enamelled ware denies the value of science in the immediate problems of his work.

The available literature on the subject is limited, it appears, to translations of three books by the late Dr. Grünwald, and three publications of the American Government. There are four American technical journals dealing with the matter and four German of varied utility. The author is of opinion that the safeguarding duty of 25 per cent. on foreign enamelled ware will prove to be the salvation of the English industry, which since the war has been gradually fading under the full blast of continental competition.

As in many another industry, the success of enamelling depends in a great measure upon the suitable preparation of the surface to which it is to be applied, and for this reason the blanks are not only made of iron and steel of specified compositions, but also must be properly cleaned by heating to remove the grease, or by pickling in acid. Both sulphuric and hydrochloric acids are used and also "nitre-cake," a crude form of bisulphate of soda obtained as a by-product of nitric acid manufacture. The blanks are afterwards washed and given an anti-rust treatment with alkali. The disposal of the sludge arising in this process is a problem of no mean magnitude, because every ton of hydrochloric acid used produces about 60 tons of sludge.

Enamelling is a branch of the ceramic industry, the principal ingredient of enamels being silica in the form of quartz, flint, sand, felspar or sodium silicofluoride. A chapter is devoted to the various raw materials used for making the frits; their composition, utility, comparative prices and some chemical information regarding purity and testing are given. Special emphasis is laid upon the testing of felspar, one of the most important components, because it is very variable in composition, and unless these variations are checked and corrected disastrous results may follow. For enamels to be used on vessels intended for cooking purposes lead compounds may not be used.

Another chapter deals with clays and other materials that are added in the mills when the frits are being ground in order to keep the enamel substance in suspension, and a further section discusses tin oxide and its substitutes, which play so important a part in the production of enamels.

Considerable space is given to the very interesting subject of the calculation of batch formulæ, and a valuable table shows the percentages of enamel components after melting of all the more important ingredients. Details are given for getting at the composition of the finished enamels resulting from known mixing formulæ. The use of graphs for the purpose of eliminating much calculation is explained in language well suited to readers who have not had the advantages of an advanced scientific training. Indeed, it may be said of the book as a whole that it is written in terms that will be plain to the most "practical" enamellers. The physical properties of enamels finds adequate explanation; then coming to the actual preparation, the author alludes to the prevalence of great secrecy on the part of the various firms with regard to their formulæ, which are carefully preserved from competitors who, he says, are quite likely to be using an identical or a similar mixture. Many recipes which attained value by virtue of the goodwill attached to them have changed hands for considerable sums of money.

Care over details and scrupulous cleanliness appear to be two of the essentials in successful enamelling. Allusion is made to the fact that if a batch is composed of the same proportions of potash, silica and alumina as are contained in felspar, it will not yield the same result as when the mineral itself is used. This is due to the fact that the separate components have different melting points while the original rock melts as a whole. The melting takes place in a reverberatory furnace, the lining of which forms the subject for some discussion. Furnaces are constructed to take a batch of 2 tons, but it is held that batches of 600 lb. are more economical in the long run. A white batch should melt in about ninety minutes, a grey taking twenty minutes longer. Technical details for getting a good melt are presented in a very practical way and the disadvantage of night work is insisted upon, because of the lack of supervision.

The molten enamel is usually run into cold water in order to produce a friable, granular frit, for though air cooling may give greater opacity, there is always the risk of devitrification, apart from the greater difficulty of grinding. The wet frit is dried in the furnace flues and weighed into bags for future use. In modern practice the open pan system of grinding has given place to tube mills with flint balls. A mill 4ft. 6in. in diameter should run at 28 revolutions per minute to give best results. Further economy is found in the use of ball bearings for the mills. The fineness of the ground enamel is of prime importance; the usual figures are, for ground coats, all through a 40-mesh; for finishing coats, all through a 60-mesh. The lining of the mill is a matter of some moment, and there is reference to American experiments with rubber linings for which strong claims of efficiency are made.

The purity of the water supply has its bearing upon the problem, as the presence of carbonates is inimical to the final gloss. It is the practice to boil the clay, to be added as a suspensory agent, in the water to be used for grinding and thus deposit the carbonates of magnesium and calcium; these, it is said, are separated at the same time as the impurities of the clay, but the idea seems to savour more of fond hopes than actual realisation. Enamels made from pure water are in every way superior.

The methods of application of the enamels to the blanks are: dipping, brushing, spraying, draining and dusting; the first being that generally adopted in England. The author is a little inclined to treat the dermatitis produced in some workers when handling chromium enamels rather too lightly; this is really a serious matter, concerning which in many

industries the Home Office has laid down stringent regulations. As regards firing the furnaces, it is stated that oil firing, though cleaner, costs 50 per cent. more than coal. Producer gas is largely used, but electric furnaces are awaiting the advent of cheaper current. When coal is used it should contain not more than 0·5 per cent. of sulphur and have a calorific value of 7500 B.Th.U. The type used in blast-furnaces is suitable.

This is a very clear and informative work that should be of considerable value to the industry.

The Cleaning of Coal. By W. R. CHAPMAN and R. A. MOTT. London: Chapman and Hall, Ltd. Price 42s. net.

As is pointed out both by the authors in the body of this work and by Dr. R. V. Wheeler in the introduction which he has furnished for it, coal cleaning in this country is a relatively modern process, which has only attracted really serious attention within quite modern times. Corresponding with this position in the art of coal cleaning, the literature of the subject is similarly of quite modern growth. Up to the beginning of the present year there was no English book devoted solely to the subject of coal cleaning, but within the current year no less than three books on the subject have been published in this country. It may at once be said that of these three the present work is distinctly the most complete. The authors have dealt with their subject very exhaustively and very thoroughly and have fairly covered the whole field. They begin with a very full and complete description of raw coal and of the nature of its impurities; like most other writers, they distinguish between the inherent and the adventitious mineral matter in coal; they differ, however, from many other authorities in restricting the term inherent mineral matter to the inorganic constituents of the coal-forming plants, and they thus distinguish between inherent mineral matter and fixed mineral matter, whereas many other authorities use the two latter words indifferently. It makes no difference which of these definitions is adopted, as long as there is no possibility of confusion, and it can fairly be said that in the present case the authors have been careful to define exactly what they mean by each phrase, so that no fault can be found with their definitions on that score. On the other hand, they have not been careful to point out the difference between the percentage and the composition of ash and of mineral matter; in fact, they use the words ash and mineral matter as though these two were the same thing, whereas, in the vast majority of cases, the ash, the residue of the mineral matter after incineration, differs both in weight and in composition from the mineral matter originally present in the coal. For the most part, the work may be described as thoroughly up to date; it is hardly the fault of the authors that, in a book completed in February of this year, the latest Birtley dry cleaning table to be described is the Y table, seeing that information concerning a still later pattern, the so-called V table, although available, was not actually published until some six months later. All writers on technical subjects, especially subjects like the present one, which are attracting a great deal of attention and to which many inventors are devoting their energies, are liable to these difficulties, and it may fairly be said that every such technical book is bound to be to some extent out of date while passing through the press, even although it may be printed with all reasonable dispatch. Perhaps the only portion of the present work which may be considered as really behind what might fairly be expected is the section devoted to the theory of coal washing. The authors, like practically all others who have preceded them, base all their theory upon the well-known Rittinger Law; this law, although only enunciated about the middle of last century, really depends upon Newton's Law that resistance to motion varies as the square of the velocity. Based upon this, Rittinger has succeeded in deducing a comparatively simple formula for the ultimate falling velocity of a single sphere in a large body of fluid, and this law has been accepted and quoted by practically all writers on the subject. It has, however, recently been pointed out by Mr. R. G. Lunnon in his papers read before the Royal Society—"Proceedings" of the Royal Society, A, Vol. 110 and Vol. 118—that this law does not really hold, and in the case of pieces of coal the actual observed ultimate velocity may differ from that calculated by Rittinger's formula by as much as 20 per cent. It is, of course, known and recognised by everyone, including the authors, that at the very commencement of the fall the Rittinger Law does not hold, and even for some little time after the commencement of the fall the law followed is that first enunciated by Stokes. It is highly probable that, when dealing with relatively large particles of high specific gravity, Rittinger's Law may be very nearly true, but, as already stated, it is not applicable to coal, more especially to the smaller sizes. These facts vitiate to a great extent the conclusions enunciated by the authors of the present work and show that their views on the theory of separation by washing need careful revision; unfortunately, experiments show that no simple formula will meet the case. The authors pay considerable attention to the theory of the jig and appear to realise that in no case is the Rittinger formula applicable to the jig, because the ultimate falling velocity of the particle is never reached in these appliances, and the authors quite correctly say that it is thus easy to explain the ability of the jig washer to effect good separation on a range of sizes much greater than would be deduced from Rittinger's Law of ultimate falling velocity. Nevertheless, no consideration of the theory of the jig can be considered as really complete unless some attention is paid to the important work on the theory of the jig done by the Swedish mining engineers G. G. Bring and H. Nathorst, which are to be found set out in the *Jernkontorets Annaler* for 1921 and 1924; our authors have entirely disregarded these important pieces of work. The authors devote an interesting but somewhat too short chapter to the economics of coal cleaning, in which the various sources of cost are fully set out. Perhaps they do not sufficiently emphasise the fact that the main cost in every case is the loss of vendible coal; the purchaser who buys an uncleaned coal necessarily pays for the mineral constituents present as though they were coal, and, therefore, of value to him, whereas they are in fact not only of no value, but actually constitute a source of loss to the consumer, and the purchaser must, therefore, be prepared to pay a higher price for coal that has been properly cleaned, and this source of loss done away with. There is no doubt that he can well afford to pay an enhanced price for cleaned as against uncleaned coal, seeing that, in the words of the authors, "It is doubtful whether there is a single industrial process dependent upon the combustion of coal which cannot be carried out with a clean coal more efficiently and at a lower operating cost than with a coal containing larger quantities of incombustible matter."

The work can be recommended as giving a thoroughly correct and reliable account of the present state of this important branch of the coal mining industry.

The Spectroscopy of the Extreme Ultra-violet. By THEODORE LYMAN, Ph.D., Hollis Professor of Natural Philosophy, Emeritus, in Harvard University. Second edition. London: Longmans, Green and Co. Price 10s. 6d. net.

THE appearance of a second edition of a book on such a highly specialised subject as this, speaks volumes for the growing interest taken in what was once a field entered by only a select few, and which now promises to become the domain in which all natural sciences come together to find their common origin. This present work treats and bridges the gap between the more well-known ultra-violet rays and the soft X-rays. Like so many other branches of knowledge, this one has for its hero a man who might be called an amateur with a hobby. The man in question was a German, Victor Schumann, who was an engineer and manufacturer of machinery till he was more than forty before he started his scientific pursuits. His work belongs to that period of unequalled activity in critical scientific work—the 'eighties and 'nineties of last century—from which even the most modern investigators draw their inspiration. The author gives a deserved prominence to the way in which Schumann overcame the truly appalling experimental difficulties. For smaller wave lengths than $\lambda = 2000$ Angström units, glass prisms and lenses are more or less useless, photographic plates must be specially sensitised or fluorescent screens employed, air absorbs the rays, hence the whole instrument must work in vacuo, &c. &c. How Schumann overcame these difficulties and photographed the lines in various spectra between λ 2000 and λ 1200 is shown by the author, who extended the work to λ 500, whilst Millikan further extended the observations to λ 140, where the soft X-rays begin. The various methods of illumination, &c., and the results are discussed in the customary objective way, and they cannot very well be entered into here to any extent. It might be mentioned that the author has found that Balmer's special case of the Rydberg binomial can be applied to some of the hydrogen lines in the Schumann region. By far the greatest interest centres round the various forms of vacuum spectrometers. Schumann used a prism instrument of ordinary type with fluorite prisms and lenses, and a moderate vacuum containing residual hydrogen, whereas the author employed a convex grating and high vacuum, which enabled him to compute wave lengths accurately. The fairly full description of this instrument with its safeguards against losing vacuum is extremely interesting. Schumann's method of sensitising the photographic plates for the extreme ultra-violet rays by heating and diluting a simple bromide emulsion, &c., is given in great detail. In this country a great deal of work had been carried out earlier by Swan on the identical lines for producing extra rapid plates, and it is rather interesting to note that Schumann's process made his plates actually insensible to visual rays.

Taken all round, this book is, in part, extremely readable to the scientific amateur and deserves a wide circle of readers. There are, as usual, some new additions to the fearsome terminology of science, like "photo-abiotic," which the reviewer assumes to be an extension of "bactericidal" to the trypanozoa and other protozoa or, in plain English, destructive to lower forms of animal and plant life. Some expressions used by the author are peculiar, like "decreasement" for decrement, and the statement that "the region added by Millikan is much *superior* in extent to that contributed by the other two authors." The giving of the formula for silica as SiO_3 instead of SiO_2 on page 14 is rather bad in a second edition. The formula on page 93 is Rydberg's, which the author omits to mention. If the author had explained that v stands for $1/\lambda$ or wave number, which is generally put as n, and avoided the use of that letter in the right member of the equation this would make the thing more orthodox. As N is universally called the Rydberg constant, perhaps a reference to that eminent worker might not have come amiss. Still, as Bohr is similarly forgotten there may be some reason for these omissions. There is also this to be remembered, the book is not mathematical; hence the extraordinary notation on pages 54–56, which has the appearance of some grotesque form of calculus, need not be entered into. As treating the phenomenology of the subject the book is undoubtedly to be recommended.

SHORT NOTICES.

Mail and Passenger Steamships of the Nineteenth Century: The Macpherson Collection with Historical and Iconographical Notes. Edited and arranged by Captain H. Parker and Frank C. Bowen, with an introduction by A. G. H. Macpherson. London: Sampson Low, Marston and Co., Ltd. 1928. Price £3 3s. net.—This handsome volume, with its quantities of illustrations, some of them excellent reproduction of old prints in colours, is very properly dedicated to Sir James Caird, to whom the country owes the preservation of the Macpherson drawings. It is, in fact, an illustrated catalogue of that famous collection illuminated by notes which, with much industry, Mr. Frank Bowen has managed to cull from old records. An introduction by Mr. Macpherson touches upon the romance of the sea as it is found in "antiquated tin-cans," and upon the attraction of collecting old prints of steamships. "Apart from its human and historic interest," he writes, "the subject has much to attract the collector. The range of material includes all waters and every variety of steam craft. The primitive stern wheeler; the early river and coastal steamboat; the pioneer ocean paddler; the Yankee scorcher of the Mississippi and Long Island Sound; the unsuccessful auxiliary with her big spread of canvas; the Atlantic record breaker—each makes its particular appeal." And, we may add, examples of all are to be found in the plates of the volume. There are sixteen reproductions in colour, not very big but admirable in execution, and there are pages upon pages of black-and-white prints. The notes by Mr. Bowen are partly romantic—what ship is without some romance?—and partly categorical. As a source of reference for the historian of ships, the book must ever retain a value not less than its value to the artist and collector.

Engineering Education Essay for English. Selected and edited by Ray Palmer Baker, Ph.D., Professor of English and Head of the Department of Arts, Science, and Business Administration, Rensslaer Polytechnic Institute. Second edition. Revised and reset. New York: John Willey and Sons. London: Chapman and Hall, Ltd. 1928. Price 10s.—The object of this book is not very clear to the English reader. It is a collection of essays on a variety of subjects by British and American authors, all drawn from already published sources, and some of them, like extracts from Spencer's "Education," of respectable age. If the intention of the collection is to encourage wide thinking amongst engineering students, there is much to be said for it; but if it is set up as a standard of English then some of the essays could have been replaced by far better examples, some of the writers lacking that purity of style which should be set before students, and many of them neglecting that dictum of Stevenson's which should be held constantly in mind by all essay writers, "What you cannot vivify omit." The general reader who has no ulterior object like that of the student may read the essays with profit, and will welcome their appearance in a neat form well produced.

Wireless, the Modern Magic Carpet. By Ralph Stranger. London: Partridge. 1928. Price 3s. 6d.—Amongst books on wireless for non-technical people this is, in its way, the best we have come across. Mr. Stranger writes in an easy lucid style, and without ever becoming deeply technical he tells his readers in a simple way the objects of the components of wireless apparatus and explains broadly how they are effected. A characteristic of the volume is numerous plates illustrating proprietary components. No doubt these are advertisements, but they serve the very useful purpose of showing the beginner what things look like. There is a lot more about wireless than merely about receiving apparatus, and we do not hesitate to recommend the volume as an admirable present for any boy who takes a greater interest in radio reception than merely tuning in a purchased set.

BOOKS RECEIVED.

More Machines. By Percy M. Baker. London: Wells Gardner, Darton and Co., Ltd., 3, Paternoster-buildings, E.C. 4. Price 7s. 6d. net.

A.S.T.M. Tentative Standards, 1928. Philadelphia: The American Society for Testing Materials, 1315, Spruce-street, Pa., U.S.A. Price 7 dollars net.

Water Engineering. By the late C. Lagg and F. Johnstone Taylor. London: Crosby Lockwood and Son, 7, Stationers' Hall-court, E.C. 4. Price 8s. 6d. net.

Garcke's Manual of Electrical Undertakings and Directory of Officials, 1927–1928. Volume XXXI. London: The Electrical Press, Ltd., 13/16, Fisher-street, W.C. 1. Price 35s. net.

Wave Mechanics and the New Quantum Theory. By A. Haas, Ph.D. Translated from the German by L. W. Codd, M.A. London: Constable and Co., Ltd., 10, Orange-treet, W.C. 2. Price 7s. 6d. net.

Switchgear at the No. 2 Barton Power Station.

THE switchgear in the No. 2 Barton power station described in our last issue was supplied by the British Thomson-Houston Company, Ltd., which also made the switchgear for the original No. 1 station. It comprises equipments for the main 31,250 kVA turbo-alternator, 1500 kVA house service transformer, three 300-ampère feeders, and one blank feeder. In addition, there are 500 ampère main and tie bus reactors, 1000-ampère main and auxiliary bus connectors, and 500-ampère tie bus connectors to No. 1 Barton station. The total number of feeders in this section will be eight, and a further section of equal capacity is contemplated.

The main turbo-alternators generate at 6600 volts, and each machine is connected through isolating links to two banks of transformers in parallel, which step-up the pressure to 33,000 volts. The main switching takes place on the 33,000-volt side, while the metering transformers, &c., are fitted on the 6600-volt side. Duplicate bus-bars are provided and the main bus-bars are sectionalised between groups, while the auxiliary bus-bars, with the exception of the air-break switches, are continuous throughout No. 2 station. An oil circuit breaker equipment connects the two stations. Each section is coupled through cast-in-concrete reactors to tie bus-bars, so as to limit the effect of short circuits with regard to the actual short-circuit capacity involved, and also voltage maintenance on the sections unaffected by the short circuit.

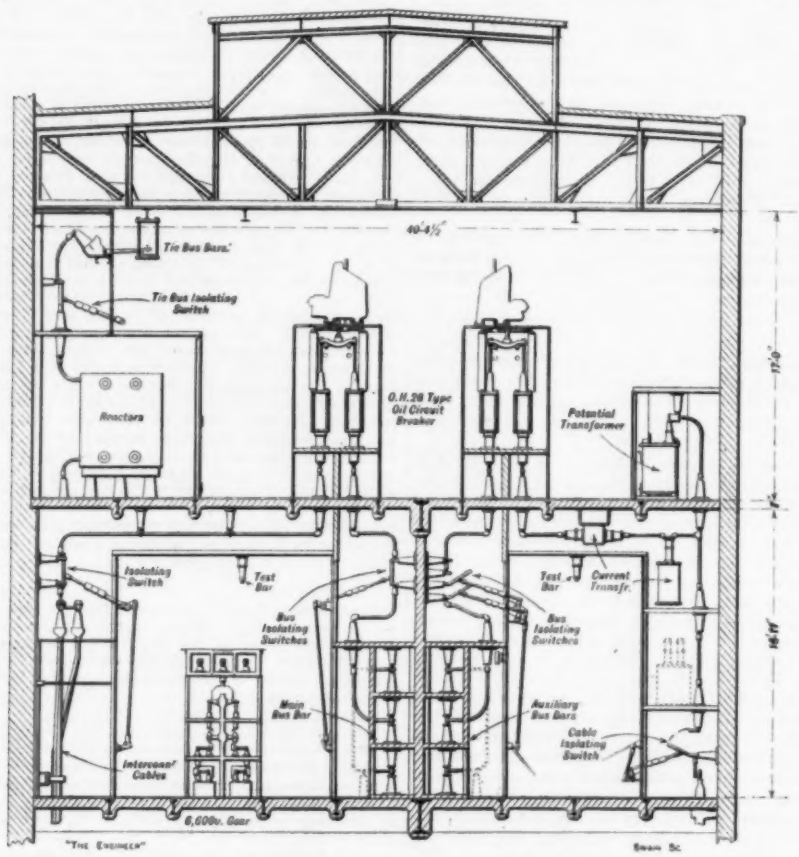


FIG. 1—SECTION THROUGH MAIN SWITCHGEAR

The switchgear is of cellular construction, and is built on two floors, the lower accommodating the main and auxiliary bus-bars, bus-bar selector switches, current transformers, feeder isolating switches and cable sealing ends, while the upper floor accommodates the oil circuit breakers, reactors, tie bus-bars and potential transformers. This arrangement is generally similar to that at the No. 1 station, but by the provision of bus-bar selector switches instead of bus-bar isolators and selectors, a very considerable saving in space is obtained. On reference to the cross section—Fig. 1—it will be seen that the 6600-volt switchgear for the turbo-alternators is situated in a gangway on the 33,000-volt bus-bar floor. The oil circuit breakers are of the well-known B.T.H. O H 28 type, which has given satisfactory service in some of the largest power stations in the world. An interesting feature of the operating mechanism for the bus-bar selector and feeder isolating switches in the 33,000-volt equipments is the provision of vermin-proof shutters where the operating rod passes through a cell door. The switches are mechanically operated in gangs of three from outside the cells. Indicating lamps show when the circuit is correct for opening or closing the isolating switches, a white lamp showing whether the oil circuit breaker is open or closed and a green lamp showing when the bus-bars of the section to which the equipment is connected are alive. For this purpose the green lamp is connected through auxiliary switches on the various tie reactor and bus interconnector equipments. On circuits of 600-ampère capacity and upwards the current transformers are of the bar primary pattern, and of the wound primary oil-immersed pattern on circuits of lower capacity. The 6600-volt metering current transformers for the generator equipments are also of the bar primary pattern, and every 6600-volt and 33,000-volt bar primary transformer is provided with a metallic lining in the insulating tube, which is connected to the primary in order to suppress corona. All the potential transformers are of the single-phase oil-immersed pattern, and a feature of the switchgear in the No. 2 station is that no 33,000-volt potential transformer is connected to the bus-bars or to a generator without an oil circuit breaker for its control. In the case of the generators the potential transformers require, naturally, to be connected to the generator side of the main oil circuit breaker, for the purpose of synchronising, but a special non-automatic oil circuit breaker is provided to enable the potential transformer to be disconnected from the main circuit, except when required for short periods for synchronising. In addition to the non-automatic oil circuit breaker, this transformer is protected by means of current limiting resistances and fuses. The feeder potential transformers are connected on the feeder side of the main oil circuit breaker.

As all metering on the generator circuits is done on the 6600-volt side, a potential transformer on the generator circuit is only connected during the synchronising period. Each potential transformer is protected with current-limiting resistances and fuses mounted in the transformer tank, which is carried on wheels. The transformers are connected to the main circuit through plug contacts, and they are disconnected by withdrawing the transformer from the cell. Each transformer is provided with a switch with which the magnetising current can be broken, and this switch is interlocked with the transformer tank in the cell, so that the transformer cannot be disconnected from the main circuit unless the magnetising switch has first been opened.

Reactors—see Fig. 2—are employed, first to connect the main bus-bar sections and limit the interchange of energy under short-circuit conditions, and, secondly, in series with the service transformers to limit the maximum short-circuit current which can flow in the event of a fault on the transformer windings. The latter arrangement is an important feature, since a fault on a house service transformer becomes practically a short circuit on the bus-bars, and the inter-position of the reactors not only limits the energy which can flow into the transformer windings, thus limiting the damage to the transformer itself, but it also helps to maintain the voltage on the bus-bars.

Characteristic features of the reactors are the absence of any organic material in the construction, and the liberal spacing of the conductors, each reactor consisting of an air core solenoid constructed of bare copper coils, wound progressively in layers and embedded in specially treated concrete piers carried on a concrete base. The spacing of the turns is proportioned to the voltage of the circuit, but the first and last few turns are given increased spacings to allow for voltage rises which build up on these turns under short-circuit conditions. By the use of coil supports, consisting of wedge-shaped concrete piers moulded round the turns, and then steam cured, intimate contact with the conductors is ensured and maximum support given to the turns. The method of manufacture is such that the concrete has very high mechanical strength to resist the stresses to which it is subjected by the coils when carrying a short circuit. The insulation is entirely non-fibrous and inorganic, so that no charring or deterioration can take place from heating in the coils, and the concrete is so treated that absorption of moisture is negligible. The concrete base is carried on substantial post type porcelain insulators, which provide adequate insulation from the ground.

To resist movement on short circuits the bus section reactors are braced by insulator struts, disposed so that the forces of attraction to which the reactors are subject are restrained by the bracings.

The generator protection is provided by circulating current across a combined generator and transformer, with the addition of core balance leakage protection on the 33,000-volt transformer winding, and separate leakage protection for the generator and 6600-volt transformer windings, the latter being operated from a current transformer mounted in the neutral earthing equipment for the generator.

Core balance protection on the 33,000-volt side of the transformers is obtained by means of core balance transformers mounted, on each of the four cables connected to the 33,000-volt transformer windings, these transformers actuating a two-pole relay on the control panels. In addition, each generator equipment is provided with an instantaneous overload relay, the windings of which are normally short circuited, but they are open circuited during synchronising. The house service transformer equipments are provided with plain overload and earth leakage protection on the 33,000-volt side The feeder protective gear is of the Merz-Beard pattern, while the protection for the main and auxiliary bus interconnections between the two stations is of the Ferranti-Hawkins type.

The control panels are of black enamelled and polished slate, mounted on a pipe framework, and forming an extension to the control board for Barton No. 1 station, which, as originally completed, was in the form of a shallow U with straight sides and base. The addition of the control panels for the No. 2 station involved straightening out one of the legs of the U, the new panels forming a continuation, in a straight line, of the base. When No. 2 station is ultimately completed, the formation will still be in the shape of a U, with a very long base. Each of the control panels has mounted above it an indicator panel, on which is represented in single-line diagram the connections of the system, the operation of the oil circuit breakers and isolating switches being indicated by means of electrically operated relays actuated by means of auxiliary switches on the various pieces of apparatus. With the exception of the bus-bar and synchronising voltmeters, which are of the moving iron type, all alternating-current instruments are of the long-scale induction pattern. The control switches for the oil circuit breakers are of the controller pattern, and the signal lamp fittings

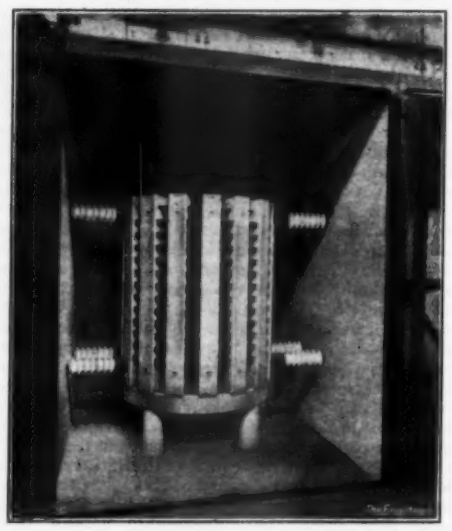


FIG. 2—REACTOR CELL

indicating the position of the breakers are incorporated in the design of the front plate of the switches, the whole arrangement presenting a neat appearance.

An interesting feature embodied in connection with the operation of the oil circuit breakers is the provision of a switch termed a "series safety switch," which is normally open, and is in series with the closing circuit of the oil circuit breaker; thus, in order to close the breaker it is necessary first to close the "series safety switch," and then operate the breaker by means of the control switch, the "series safety switch" then being returned to the normal "open" position. This rule is strictly adhered to by the operating engineers.

The No. 2 station is provided with summation metering equipment, which will ultimately indicate the total power generated by the two 31,250-kVA turbo-generators when the installation is complete. No provision is made at present for summating the output of the smaller machine. The equipment consists of one recording wattmeter mounted in the control room, an indicating wattmeter for the boiler house, and an indicating wattmeter for the resident engineer's office.

ROYAL INSTITUTION.—A general meeting of the members of the Royal Institution was held on Monday afternoon, December 3rd, Sir Arthur Keith, Treasurer and Vice-president, in the chair. Miss Edith Aird, Sir John Aspinall, Sir John Beale, Mr. R. T. Beatty, Miss K. Hartree, Viscount Hambleden, Mr. E. Hatschek, Mr. B. Hennell, Mr. C. W. G. Hindley, Mr. J. S. Oliver, Mr. R. Pigott, Miss L. Power, Mrs. E. A. Ronald, and Mr. C. Swithinbank were elected members.

A 600 B.H.P. HEAVY-OIL ENGINE.—In THE ENGINEER for November 12th, 1926, we gave an illustrated description of a new design of Bellias 600 B.H.P., 400-kW oil engine driven generator set, which was built by Belliss and Morcom, Ltd., for the Shrewsbury Corporation electricity works. The engine was put into operation at the beginning of 1927, and a duplicate set has been recently supplied and put to work. The first engine has now been running for a total period of over twenty-two months, and the first examination of the cylinders and pistons only took place after 8000 hours of service. The whole of the steam and oil engine driven plant at the Shrewsbury power station was built by Belliss and Morcom, Ltd., and the generators were constructed by Thos. Parker, Ltd., or the Rees Roturbo Manufacturing Company, Ltd. Some Bellias oil engines of the open type are also included in the station equipment. The average fuel consumption for the whole of the oil engine driven plant for the year ending September 30th, 1928, was 0·696 lb. of oil per unit, and the lubricating oil used over the same period averaged 0·007 lb. per unit. The fuel consumption of the main engine worked out at an average of 0·671 lb. per unit.

The Case-Hardening of Steels by Nitrogen.

WE have to thank John Brown and Co., Ltd., for the following very complete account of a method of treating steel which would appear to have a promising future.

Very considerable interest is being taken in engineering circles in the process of case-hardening of special steels by the action of Nitrogen, and the following particulars, giving a brief description of this process—the Nitration Process—will be of interest to engineers in every branch of service.

This process is the invention of Dr. Fry, of Messrs. Fried. Krupp, Essen, who have taken out patents in all countries. The patent rights for the process are held in this country by Nitralloy, Ltd., Norris Deakin Buildings, Sheffield, who have granted licences for the manufacture of the special Nitralloy Steels required to John Brown and Co., Ltd., Atlas Works, Sheffield, and Thos. Firth and Sons, Ltd., Norfolk Works, Sheffield.

THE EFFECT OF NITROGEN ON STEELS.

For many years nitrogen was considered to have a merely harmful effect upon steel, lowering, in particular, the elongation and resistance to shock. Braune, in 1905, demonstrated this harmful* effect, and showed further that iron when heated to a temperature of 800 deg. Cent (1472 deg. Fah.) in a current of ammonia gas readily absorbs nitrogen.

Dr. Fry, from 1918 onwards, carried out a thorough investigation into the question, and established the existence of several different Fe-N combinations, *e.g.*, Fe_4N with 11·1 per cent. N; Fe_2N with 5·9 per cent. N, and, finally, a solid solution with a low nitrogen content. He also defined the conditions under which each may be formed, and discovered that steels which have absorbed nitrogen undergo a peritectoidic change at 580 deg. Cent. (1076 deg. Fah.). If the nitration takes place below that temperature, the nitrogen is absorbed mostly as a solid solution and not as a nitride.

The results of Fry's investigation did not at first appear to have any commercial value, as the nitriding of ordinary carbon steels only gives a slight increase in the hardness, and, at the same time, makes them brittle, owing to the nitrogen penetrating right through the core of the material. It was later found that by the use of certain special steels, not only was this deep penetration of the nitrogen prevented, but also the thin case of solid solution of nitrogen formed was of great hardness, and its hardness gradually diminished inwards, so that the case was solidly merged into the core, giving full assurance against peeling. Further investigations finally brought forth the case-hardening process, of which some details are given below. This process has already found very wide application in Europe and the United States of America, and its field of usefulness is rapidly extending.

NITRATION PROCESS: DESCRIPTION.

The Nitration process consists in subjecting finish" machined parts made of special steels, known as Nitralloy Steels, to the action of ammonia gas in an electric furnace at a temperature of 500 deg. Cent. (932 deg. Fah.) for the length of time necessary to produce the depth of case required. The full period of ninety hours' nitration produces a depth of case of ·031in. The following curve shows the time required for various depths of case.

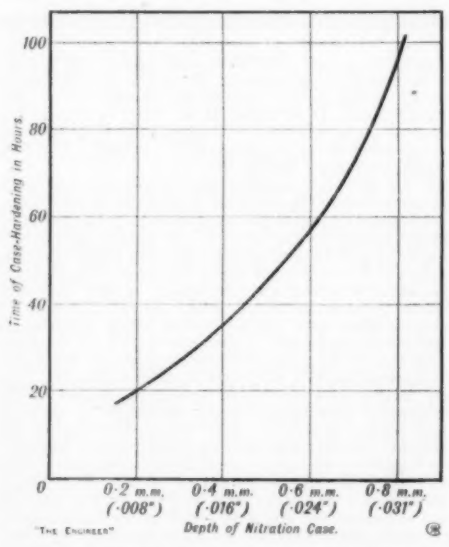


FIG. 1—TIME AND DEPTH OF NITRATION

The parts to be nitrated are placed in a gas-tight box of special heat-resisting steel, provided with inlet and outlet tubes for the circulation of the ammonia gas. The parts are loosely placed in the box without any packing material, the individual layers being separated by nickel wire netting to allow free circulation of the gas. The box is then put into the electric furnace, the door sealed up, and the furnace is brought up to the temperature of 500 deg. Cent. (932 deg. Fah.) required. The ammonia is supplied direct from cylinders, and discharges through a water bottle giving about ½in. back pressure. The only requirements during nitration are to see that the flow of ammonia is maintained, and that the temperature of the furnace is held steady within ± 5 deg. of 500 deg. Cent. (932 deg. Fah.). Several furnaces can be supervised by one man.

When the period of Nitration is completed, the furnace is allowed to cool down quickly to 370 deg. Cent. (700 deg. Fah.), the box is taken out, and the parts removed as soon as they are cool enough to handle. No further treatment of any kind is required, and the parts can be used immediately, unless it is simply desired to get rid of the extremely thin grey film on the surface. This can readily be removed by buffing or lapping. Those portions which must be kept soft, such as threads, keyways, &c., can be fully protected by tinning or otherwise, against the action of the ammonia gas.

SURFACE HARDNESS PRODUCED BY NITRATION.

(*a*) *Hardness: Wear Tests.*—The case obtained by nitration is much harder than anything previously known in the case-hardening of steels. It will cut glass and even quartz; it cannot be touched with special testing files. Brinell figures converted from readings of a Herbert Pendulum Hardness Tester are 900 to 1100, with Shore Scleroscope readings of 102 to 113. The following table gives the average Nitrated Nitralloy Steel hardness, as compared with other standard hardness figures:—

	Brinell.
Nitralloy	900–1100
Cr Van (·50 C, 1·00 Cr, ·20 Van), C.H.	742
H.S. steel tool bit, hardened	675
1·25 per cent. carbon tool steel	627
Tool steel (12 per cent. Cr, 1 per cent. Van, 2 per cent. C)	627
Chrome magnet steel (C ·85, Cr 2·75)	627
·80 per cent. carbon tool steel	555
4 per cent. nickel chrome steel (C 60, Cr 1·0 per cent.)	555
Hard white iron	450
Hard cast iron	210

The resistance to wear is very great, amounting, as shown in the following table, to at least ten times that of cemented and quenched steels. These tests were taken on an Amsler machine, and show no wear with Nitration Steel under a load of 80 kilos., whereas with the other steels shown the loss of weight exceeds 2 centigrammes. With a load of 200 kilos. the loss of weight of Nitrated Steel was less than one-tenth of the loss of the other steels under a load of only 80 kilos.

Wear Tests: Loss of Weight in Centigrammes.

Load in kilos.	Case-hardened and quenched steels.				Nitrated steel.
	Chrome C.H.	Nickel molybdenum C.H.	Cr Van C.H.	Cr–Ni–Mol C.H.	
20	0·48	·19	·16	·16	Nil
30	1·35	·60	·44	·38	Nil
40	2·24	1·15	1·15	1·11	Nil
50	2·35	1·49	1·60	1·71	Nil
60	2·43	1·98	2·06	2·35	Nil
70	2·62	2·58	2·09	2·40	Nil
80	2·98	2·47	2·08	2·79	Nil
200	—	—	—	—	·26

Recent tests on nitrated cylinder liners for motor car and aeroplane engines have given remarkable results. After running for 30,000 miles under identical conditions, nitrated liners show no measurable wear, whereas cast iron cylinder liners have worn ·4 mm. oval. In addition to longer life for the nitrated cylinders, there is also the advantage that there is no wear on the pistons and rings. Piston speeds have been raised by as much as 400 r.p.m. with no detrimental effect. The consumption of oil decreases when nitrated crank shafts and nitrated liners are used.

(*b*) *Safety: Perfect Union with Core: Microstructure.*—The following diagram—Fig. 2—shows that the maximum hardness of the nitrated case is immediately under the surface, tapering off gradually towards the core. The case is, therefore, in perfect union with the core, so that all risk of peeling or spalling is definitely eliminated. This constitutes an improvement on the case produced by previous methods of cementation where the line of demarcation between the outer case and the inner core is clearly marked.

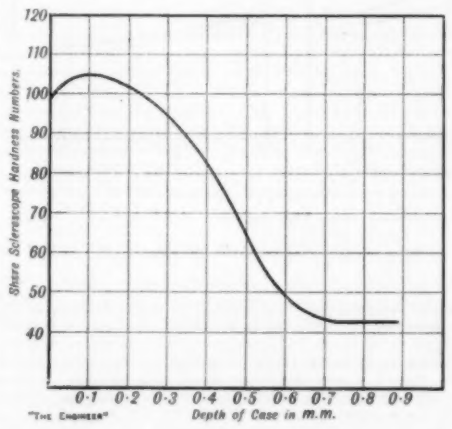


FIG. 2

Nitralloy Grade 3 Steel, oil-treated and re-heated to give 100 kilos. (64 tons) tensile. Nitrated for 90 hours.

The depth of penetration of nitration is best measured by taper grinding a round bar after nitration, so that one end is left untouched and the other end is well below the maximum depth of nitration possible. The results obtained by this method are as shown on Fig. 3, giving the microstructure of the nitrated case after ninety hours' nitration.

NITRALLOY SPECIAL STEELS—SEE FIG. 4.

The outstanding results of the Nitration Process can only be obtained by the application of the process to certain special steels, called Nitralloy steels. These steels contain a certain percentage of aluminium, both on account of the action of aluminium in the formation of the extremely hard surface on the steels when submitted to the action of the nitrogen during nitration, and also because of the excellent physical properties produced in the core.

The variations in the carbon contents of the Nitralloy steels are governed solely by the mechanical properties required from the steel forming the core, as the percentage of carbon within normal limits does not affect the hardness of the case produced by nitration. Too high a percentage of carbon may, however, be prejudicial to the obtaining of the very best results. The hardness figures are the same for all grades of Nitralloy steels. Six grades of Nitralloy Steels are at present available, with carbon contents ranging from ·20 to ·65 per cent., and particulars are given below of the test results obtained with the three grades most generally used.

Grade 3 steel, after oil hardening and tempering, cannot be softened much below 80–90 kilos. (51-57 tons per square inch), and is, therefore, reserved for parts which do not involve difficult machining and where maximum strength is required in the core. For example, in the manufacture of tappets, high tensile strength is required under the case, and Grade 3 steel, heat treated at 550 deg. Cent. (1022 deg. Fah.). is particularly suitable.

Grade 5 steel allows of a softer steel after heat treatment—70–75 kilos. (44–47 tons)—and is recommended for parts involving difficult machining, *e.g.*, cam shafts, especially where long and hollow, gudgeon pins, crank shafts, gears, &c.

Grade 7 steel is exclusively used for wearing parts where the surface pressures are not high.

NITRALLOY STEEL, GRADE 3.

After treatment, the characteristics are as follows:—

Quenched in Oil from 825 deg. to 850 deg. Cent. (1517 *deg. to* 1562 *deg. Fah.*).

Tempered at.	Max. stress in tons per sq. in.	Yield in tons per sq. in.	Elongation, per cent.	Impact, foot-lb.
550° C. (1022° F.)	76	69	12	32
625° C. (1157° F.)	64	57	21	42
725° C. (1337° F.)	56	51	25	54

The last treatment is the one mostly used for gears. It will be seen that the minimum strength obtained by tempering this grade of steel is 54 to 57 tons per square inch. In this condition it is fairly easy to machine.

NITRALLOY STEEL, GRADE 5.

This grade is somewhat softer than Grade 3. It is suitable for the same uses, and is recommended where the greatest strength is not required under the case-hardening surface, and where easier machining is desired.

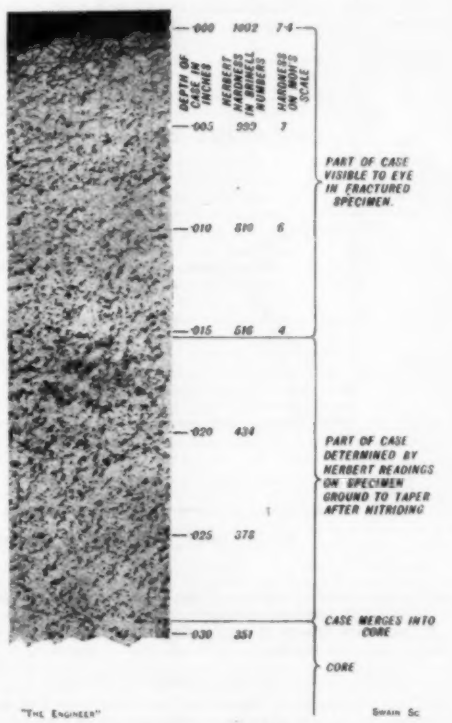

DEPTH OF CASE IN INCHES
HERBERT HARDNESS IN BRINELL NUMBERS
HARDNESS ON MOHS SCALE
·000 1092 7·4
·005 999 7
·010 810 6
·015 516 4
·020 434
·025 378
·030 251
PART OF CASE VISIBLE TO EYE IN FRACTURED SPECIMEN.
PART OF CASE DETERMINED BY HERBERT READINGS ON SPECIMEN GROUND TO TAPER AFTER NITRIDING
CASE MERGES INTO CORE
CORE
"THE ENGINEER"
SWAIN Sc.

FIG. 3—DEPTH OF NITRATION

After treatment the characteristics are as follows:—

Quenched in Oil (*or Water*) *at 875 deg. to 900 deg. Cent.* (1697 *deg. to* 1652 *deg. Fah.*).

Tempered at.	Max. stress in tons per sq. in.	Yield in tons per sq. in.	Elongation, per cent.	Impact, foot-lb.
550° C. (1022° F.)	70	64	15	34
625° C. (1157° F.)	57	51	22	50
725° C. (1337° F.)	48	44	30	62

The minimum strength obtained by tempering is 48 tons per square inch, in which condition machining is very easy.

NITRALLOY STEEL, GRADE 7.

This steel is softer than Grades 3 and 5, but the nitrated case has still the same hardness. It is always used where

* See Braune, *Stahl und Eisen*, 1906, No. 22; Stromeyer, *Stahl und Eisen*, 1910, No. 42; N. P. Tchijevsky, *Rev. Soc. Met. Rus.*, 1913.

maximum impact, elongation and extremely easy machining are desired.

The characteristics are as follows :—

Annealed at.	Max. stress in tons per sq. in.	Yield in tons per sq. in.	Elongation, per cent.	Impact, foot-lb.
800° C. (1472° F.)	32	29	37	76
Quenched in Water at 900 deg. to 925 deg. Cent. (1652 *deg. to 1697 deg. Fah.*).				
Tempered at.				
550° C. (1022° F.)	44	41	27	76
625° C. (1157° F.)	38	35	33	86
725° C. (1337° F.)	35	32	37	101

WORKING OF NITRALLOY STEELS.

The physical characteristics of the Nitralloy steels are similar to those of the highest quality nickel-chrome steels, and it is possible to obtain the tests required in the core of parts by suitable heat treatment, these tests not being affected by the subsequent nitration of 500 deg. Cent. (932 deg. Fah.).

The working of them is in every way similar to that of nickel chrome steels, and they have excellent forging properties, and machine satisfactorily in both the annealed and the heat-treated conditions. They must be heat treated to impart the desired physical properties to the core, and then machined as usual. Before nitration, the strains set up by forging, rolling or machining must be relieved, by annealing at 540 deg. Cent. (1000 deg. Fah.) for about five hours, advisably between rough and finish machining. If all strains are removed, the parts after nitration will be free from distortion or irregular growth.

All scale resulting from forging or heat-treatment must be completely removed from the surfaces which are to be nitrated.

The low average carbon content of the various Nitralloy steels, together with the small amounts of alloys present, produce easy machining in rolled bars, forgings, stampings, or castings. These steels show the same degree of smoothness and free-cutting properties, both in the heat-treated and the annealed condition, as the highest grades of alloy steels of corresponding strength.

A very high degree of mirror finish can be obtained on them without difficulty.

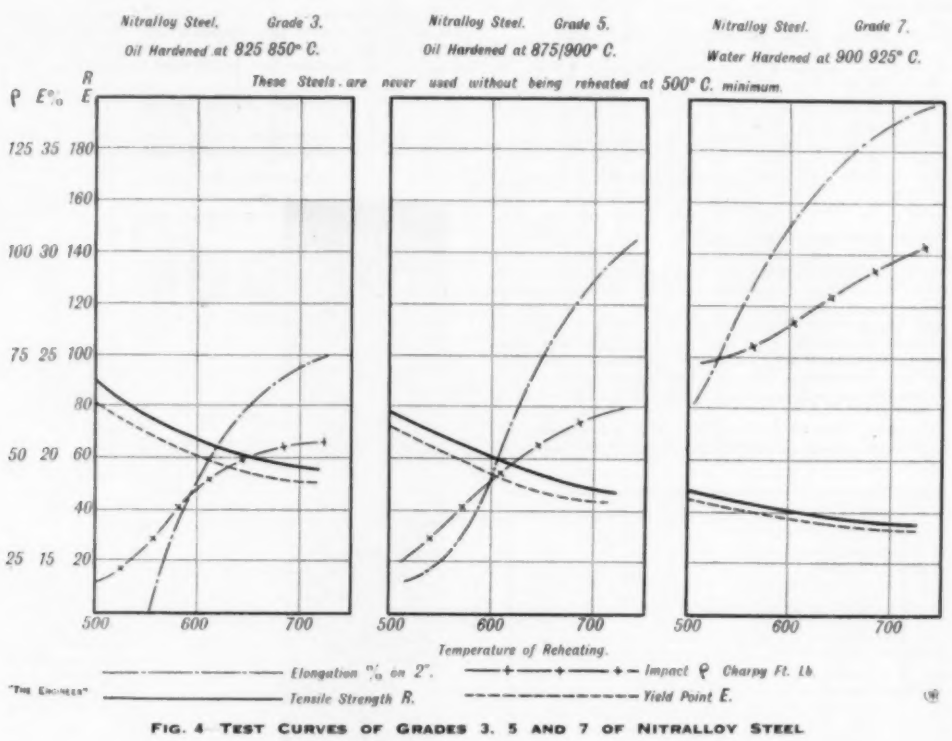


FIG. 4 TEST CURVES OF GRADES 3, 5 AND 7 OF NITRALLOY STEEL

ADVANTAGES OF THE NITRATION PROCESS.

(*a*) *No Distortion of Parts during Nitration.*—The low temperature of 500 deg. Cent. (932 deg. Fah.) at which nitration is carried out, removes all risk of distortion during nitration, provided always that all stresses set up in the steels by working or machining have been previously removed by annealing above that temperature. It is essential that the recommendations given for the machining and treatment of these steels be closely adhered to.

(*b*) *No Deformation.*—Parts are free from stresses when taken from the nitration boxes, provided they were thus free when put into the boxes, so that all risk of subsequent deformation is avoided.

(*c*) *No quenching cracks.*—No quenching is required with the Nitration process, so that all risk of hardening cracks is completely eliminated.

(*d*) *Finish-machined Parts.*—Parts are nitrated in the finish-machined condition, and in many cases are immediately ready for service when removed from the boxes, the surfaces being perfectly clean.

(*e*) *Retention of Hardness up to 500 deg. Cent.* (932 *deg. Fah.*).—The nitration case retains its hardness up to the temperature at which the treatment is applied, namely, 500 deg. Cent. (932 deg. Fah.), whereas other steels, cemented and quenched, begin to lose hardness at 180 deg. to 200 deg. Cent. (350 deg. to 390 deg. Fah.). In the case of shafts heating up owing to faulty lubrication, there would be no risk of trouble with Nitrated Steel, whereas with ordinary case-hardened steel "seizing" would take place. In the case of gudgeon pins, &c., this retention of hardness is of considerable advantage.

(*f*) Polished Nitrated Steel does not heat up when running with aluminium alloys, such as duralumin. Anti-friction devices or brakes can, therefore, be eliminated.

(*g*) *Corrosion.*—The Nitrated case has considerable resistance to the corrosive action of fresh or salt water, steam and moist atmosphere.

The Nitration Process is cheaper than cementation and quenching, owing to :—

(i.) Low current consumption, due to low temperature of 500 deg. Cent. at which carried out.

(ii.) Quenching is entirely eliminated.

(iii.) No case-hardening compounds are required. The parts after Nitration have a matt surface, but are ready for immediate use.

(iv.) The amount of ammonia gas used is very small.

(v.) Only occasional supervision of the furnaces is required, and labour costs are low.

The Industrial Situation.

THE argument that evidence is found in the present industrial situation of a definite transfer of activity from the north to the south was closely analysed by Mr. J. H. Jones, Professor of Economics at Leeds University, addressing members of the Darlington Historical Society on Thursday, November 29th.

Having outlined the difficulties of forming judgment on the particular trend that industry is making at the moment, Professor Jones said that statistics recently published by the Ministry of Labour conveyed the impression that there had been a marked movement of industry from the north to the south, and this view was reinforced by odds and ends of information. If the north was in a process of decay and the south was the coming industrial area of the country, it was, of course, a very serious matter for the people residing in the north, but he hoped to show that the fear was not too well founded.

The Industrial Transference Board affirmed that fundamental changes had taken place in the industries of the country, and that the big task of the nation was to transfer people in depressed industries in the north to new and developing industries that were springing up in the south. The Board aimed at transferring the surplus working people in the north to the more elastic industrial system which was centred upon London, and which spread across to Birmingham and down to Cornwall. In accepting that view, the Board was simply agreeing with an extremely widely held opinion.

A line drawn from the Humber to Bristol divided the country into two distinct industrial areas. In the southern area the population was growing far more rapidly than in the north, and, similarly, the number of people employed and the volume of business activity was increasing more rapidly. There, there was superficial evidence of prosperity, whereas in the north there was superficial evidence of deep depression. If it was true that industry was moving southwards, it was not the first time that a change of that type had occurred in this country. Industry was not a static thing. It was constantly changing its form, locality and method of control.

It was dangerous to rush to conclusions because industrial activity was seen in the south. The new places in the south were very often in the middle of miles of agricultural country, whereas in the north new townships grew up unobserved as the area there was already largely industrialised. Another factor was that during the war there was a flow of labour from the south to the munition factories and coal mines in the north, and the balance of labour allocation was then upset. Even if allowance were made for these two facts, there remained the position that there had been a development in the south which had not been shared by the north. This was due to the development of electrical power—which liberated a large mass of industries from the coalfields—cheaper land and labour, and a lesser risk of industrial trouble. A third factor was the international situation which resulted in industries like cotton, wool, steel, engineering, shipbuilding and coal, suffering because of their connection with markets abroad. When these industries suffered from depression, a mass of miscellaneous industries which depended upon them in turn tended to sag. A revival of the bigger industries would build up dozens of industries that depended upon them.

The industries growing up in the south were almost entirely dependent on the domestic market or connected with luxurious expenditure, and those things were not for the north at the present time. When the time came for a general recovery in the export industries, the people in the industries now adversely affected would again be able to afford "trimmings," and those industries would be developed to provide them.

In spite of appearance to the contrary, the world was not going to be split up into a group of isolated units, and business in each country would once more develop along the old lines. They would find German capital penetrating into Russia and France, even while politicians quarrelled among themselves. The world would once more become closely bound up and different parts would trade with each other. When that time arrived, there would be the same markets in the world for our industries as before, except in so far as the competitive strength of any industry may have been impaired. There would possibly be contraction in the Lancashire cotton trade and in the coal trade, but he had failed to find any true evidence of loss in competitive strength of the steel and engineering trade. We were now suffering not so much from a world trend away from this country, as a very exceptional combination of circumstances, each of them of a temporary character.

The steel industry had been depressed during the last two years, very largely owing to the tremendous competition of imports into this country. The source of these imports was not Germany, but Belgium and France. When the currency of these two countries was examined, it was found that the extreme competition which came from them was due to factors which were already beginning to diminish in importance and they would gradually die away.

Professor Jones then went on to say :—"The increase of unemployment during recent months does not perturb me very much, except, of course, that I regret to see individuals suffering. The increase is largely the result of tremendous efforts that have been made during the last year or two to economise the human element in every form, and that sort of unemployment is not so depressing in character as other kinds of unemployment. I believe that the industrial situation to-day contains evidence that we are steadily making progress. Actually, one of the dangers of the moment is that a revival in trade might come too quickly."

There were definite signs, concluded the lecturer, that the trend southwards was nearing its end, that the revival of the basic industries in the north would not be long delayed, and that there would be an increasing capacity to re-absorb the unemployed. As this process continued, subsidiary industries would grow up and then the trend would not be from the north to the south, but from the south to the north.

Institution of Mechanical Engineers.

A MEETING of the North-Western Branch of the Institution of Mechanical Engineers was held at the Engineers' Club, Albert-square, Manchester, on Thursday, November 29th, when Dr. H. W. Swift, M.A., Assoc. Member, presented his paper on "Power Transmission by Belts: An Investigation of Fundamentals." Professor W. H. Watkinson occupied the chair.

Mr. F. Blezzard, opening the discussion, said that, from an academic point of view, the paper was rather beyond criticism, but from an economic industrial point of view, criticism would not be of any harm. He thought it would have been more satisfactory if a definite line had been drawn between belts which employed dressings and those which were run dry. He was of opinion that such values of friction coefficient as had been shown were not a definite advantage. In the case of a belt which had a coefficient of friction of ·2, and transmitted 1 H.P., if the friction were increased to ·6 the horse-power would be 1·8. He suggested that ·6 to 1 was quite unnecessary. If a curve were drawn the most satisfactory value of the coefficient of performance would be about ·8, and one usually found that dry belts would give that. The coefficient of friction was then ·5, with a tension ratio of 5. With regard to the slip curves, he thought many engineers would pay little attention to the loss or difference in loss between the fabric belt and the leather belt. If a unit of power cost ½d., with a 15ft. drive, by substituting a rubber friction belt for a leather belt that belt would pay for itself in five years, owing to the saving in power which it effected over the leather belt.

Professor Dempster Smith said that he would like Dr. Swift to keep in mind the distinctive difference between creep and slip. In the workshops they had adopted pulleys with cork, leather, or paper faces, in order to increase the frictional resistance between belt and pulley. They appeared to be retarding the natural effort, and, according to Dr. Swift, every effort made to retard the creep in the pulley was to the detriment of the drive. In this country belt speeds were limited to about 4000ft. or 5000ft. per minute. The centrifugal force would effectively interfere with the transmission beyond that speed, yet C. Otto Gehrckens transmitted power at something like 7000ft. per minute, or about 120ft. per second, and, according to prevailing theory, the belt should have ceased to transmit power long before it had reached that speed. The pulleys were very large, being approximately 8ft. and 16ft. diameter. In that particular drive the belt was fully a yard wide, with all joints scarfed and cemented, and without lacing or riveting, and had an effective tension of about 160 lb. per inch of width.

Mr. W. H. Bowyer said that in view of the possibility

of variation which would occur in all types of belting, particularly leather and leather compound belting, the results of tests could not be regarded as being representative of the average of each particular kind of belting. From the creep table given by the author, it appeared that leather and leather compound gave higher creeps than rubber belts. That showed that the former had a distinct advantage over the latter, i.e, the leather and leather compound belt had a distinct advantage over the rubber belt from the point of view of creep. From other tables it would be seen that the leather and leather compound bets had higher coefficients of performance than the rubber belts, so that it seemed that if those tables were regarded as a kind of comparison of the various kinds of belting, they appeared to be contradictory, and it indicated that those tables should not be taken as giving any indication of the relative merits of the kinds of belts as mediums for the transmission of power, but only as showing the relative values of the particular characteristics under consideration. Dr. Swift had spoken a good deal of the "coefficient of performance" of belts. The coefficient of performance, while giving a very good indication of the belt's usefulness from a tension point of view, should not be taken as a basis of comparison of belts as regards their performances generally. It was dependent upon the maximum tension per unit cross section which the belt was capable of bearing without detriment to the material. The coefficient of performance had one very important advantage—it indicated how much the belt was likely to exert pressure in addition to the pressure required to transmit the power.

Mr. John Leigh was of opinion that the application of Dr. Swift's results to the practical use of belts had scarcely been deep enough. There was a very old theory that at a certain critical speed with a belt drive the power-transmitting capacity was reduced, and, finally, a velocity would be reached at which, theoretically, the belt would transmit no power. Personally, he was of opinion that that was one of the most idiotic pieces of reasoning they could have. Drives had been installed, and had transmitted power above that speed at which, theoretically, they should have done nothing.

Mr. F. S. Gifford said that in a belt it was always believed that the tension remained much the same when travelling round the pulley. But the tension on the inside of the belt would be considerably less than the tension on the outside of the belt going round the pulley. A leather belt, being more solid, lent itself to very much more rapid deterioration than a belt which was built up in such a way that the outside ply was capable of sliding over the ply next to it. In the same way, the ply on the inner side of the belt stretched to a lesser extent than the one on the neutral axis.

Mr. H. C. Young said Dr. Swift had had to keep to low speeds in testing the belts, but he wished to ask if he had run his tests at 5000ft. or 6000ft. per minute, what difference he would have expected in the data which he had gathered. Further, what difference would he have expected between the two experiments in the type of belting? The all-steel belt was making quite a lot of headway, and it was made of a material which had a very high modulus of elasticity. Comparing it with, say, an all-rubber belt, one would get two experiments in the behaviour of materials. One was stiff, inextensible material, and the other was extensible. What results would Dr. Swift expect from those two experiments? He had fallen out with Dr. Swift's term "coefficient of performance." Some other expressions for belt drives were badly needed. $\frac{T_1 - T_2}{T_1}$ was a clever way of expressing performance of a belt. Furthermore, to those of them who were engaged in selling or employing belt drives, or both, there seemed to be a necessity for some other terms. He thought Dr. Swift had struck something new. But on close inspection of that term, he did not think he would use it. It certainly was misleading. If they adopted the term, as Dr. Swift had suggested they should do, they would entirely neglect any question of efficiency.

Mr. A. T. J. Kersey said he had been struck by what appeared to be the very considerable increase in the coefficient of friction with the slip. He took it that, taking the coefficient of performance as Dr. Swift had defined it, and assuming that the e^{θ} rule still held with a considerable amount of slip, one could deduce the value of the different rates of slip. With the hair belt the coefficient of friction appeared to be ·475 for the 2 per cent. slip, rising to ·858 for the 3 per cent. slip, and at 4 per cent. slip it appeared to give the rather extraordinary figure of 1·06. The others were similar. With the treated belt I_q, the coefficient of friction appeared to be ·445 rising to ·59 per cent., and with the undressed belt ·292 rising to ·445 per cent. The increase of friction seemed to him to be important in comparing the undressed and dressed belts. He was unable to understand why the coefficient of friction should rise in such a way with the increased motion between the belt and the pulley. Whether the formula on which those calculations of coefficient of friction had been worked was altogether unreliable, or whether those were actual increases, he did not know.

Dr. Swift, in his reply to the discussion, thanked the meeting for the very keen way in which the paper had been discussed. There was no question that the improvement might be very real by adopting a dressing. For example, if they took the case of a belt which was able when dry merely to give a tension ratio of 2 to 1, that gave a coefficient of performance of 5; by increasing the tension ratio to 5 to 1, it was actually a fact that the load due to the belt on the bearings was reduced by 50 per cent., and the actual maximum tension in the belt for the same turning moment was reduced by about 40 per cent. If that could be done simply and without trouble, it was worth while. The analogy between a dressing and lubricant could be extended one step further. Bearings were really of two kinds. There were bearings which required continual friction, and there were bearings in which it was unnecessary to apply a lubricant for quite an extended period. And it seemed to him that, in the case of the dressing of belts, there was a very close analogy to that. Mr. Blezzard pointed out that the advantage of high coefficients of friction was not proportionately good, when one got really high coefficients of friction. On that point he must definitely agree with him. It was doubtful that a belt could maintain freak coefficients of friction were reached, unless it were kept in good condition. Even if it were maintained in that sort of condition, the increase in power would only be very slightly greater than the power which could be obtained from another belt which would require very much less care and maintenance. He quite realised the point which Professor Dempster Smith and a later speaker had mentioned in regard to the formulæ, where it had been found possible to transmit power at higher speeds than would appear possible according to the ordinary theory. The ordinary theory did not take into account that belting, when spinning, tended to take up a circular form. Professor Smith had pointed out that the power increased with the diameter of the pulley. That, of course, was perfectly true, and it was tolerably well known. The reason was that the coefficient of friction was greater according to the actual area of contact. There was no question about that. At low intensities of pressure, the coefficient of friction was in almost every case higher than it was with big intensities of pressure. That would explain why a bigger pulley was able to carry more power than a small one. Mr. Bowyer had suggested that the figures given in Tables I. and II. were contradictory. He would suggest to him that they were not contradictory, but they gave indications of entirely different things. Table I. referred to one particular property of a belt, which was definitely an elastic property; Table II. referred to another property which was a fractional property. In choosing a belt, of course, it was necessary to take both those factors into consideration. Mr. Young regarded "coefficient of performance" as a misleading term. Dr. Swift said he was afraid it would be a very long time before they would be able to provide Mr. Young with a nice formula into which he could put various belts, and really get any one number which would represent the quality of that particular belt. Those qualities were so different from one another. He submitted that that particular ratio might be clumsy, in so far that perhaps it did not look so nice, but, on the other hand, it had the merit that it did represent something. Mr. Kersey had drawn attention to the very steep rise in the coefficient of performance as the speed of slip increased. They had definitely found by ordinary static experiments that the coefficient of friction with such a material as leather did rise to a most extraordinary extent with speed of slip.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

BRITISH PATENTS.

SIR,—I venture, with all deference, to suggest that you are hardly fair to the average inventor in your leading article of November 9th. That theology, learning, science, art, &c., would persist and endure without the inspiration of monetary reward or other glittering prize is quite possible; but the bulk of those engaged therein appear to attach considerable importance to the cash nexus. So with the inventor; the possession of a patent, which may represent years of toil and years of saving, is but a sign that the inventor is as other men, anxious to sell his ability, his labour, or the produce thereof.

The cases quoted, where useless trivialities are patented in order to baulk competitors, do not concern the inventor as such; these actions are simply phases of commercial alertness or astuteness.

The three points, the three directions in which the inventor seeks reform are cost, clarity, efficient protection; the cost is high, the commercial-legal terminology is vague and indefinite, so that lack of efficient protection for the inventors' property ensues and follows as a matter of course.

Possibly the very best advice that can be given to anyone thinking of devoting time and money to inventions and patents is the same as that given by *Punch* to those about to get married—Don't. A. WILLIAMS PRICE.

Ruabon, December 1st.

A CONDENSER PUZZLE.

SIR,—Your recent article on what you describe as a "Condenser Puzzle" is of the widest interest, not only to those concerned in condenser design, but to engineers in general.

The design of condenser to which you refer embodies two features, neither of which is entirely new.

Tangential pitching of tubes in condensers is an old arrangement, but the theory that the condensate falls from tube to tube with perfect streamline regularity is entirely novel, and though it is recognised that the density of the vapour is low, can one imagine the condensate falling drop by drop and adhering to its straight—and narrow—path in a cyclone moving at 180 miles an hour?

The second feature described is the arrangement of the tube bank in V-shaped formation. This has been adopted to a certain extent by some British manufacturers for many years, but in the particular type of condenser under consideration less advantage has been taken of this formation than in the most advanced British designs. This being so, if the results you refer to are obtained in any type of condenser, one would expect them to be most pronounced in a design in which lanes are taken right through from the top to the bottom, rather than only part of the way through as in the case under consideration.

Some British manufacturers have been for years constructing a type of condenser which is described as regenerative, the basis of the design being to provide a clear passage for the steam from the top to the bottom with the air ascending to the exit. The results obtained by this type have received ample confirmation, and have been remarkable from the point of view of both high temperature and freedom of the condensate from oxygen.

These designs, as you will appreciate, are fully protected, and it is the existence of these patents which has so definitely prescribed the limitations of design of continental manufacturers, and has enabled Great Britain to maintain pre-eminence in condenser design.

Regarding the temperature of the condensate being in excess of the temperature corresponding to the steam pressure at the turbine exhaust, this is a phenomenon with which all manufacturers of regenerative condensers are familiar.

The influence of the kinetic energy of steam is rather involved and requires some very careful consideration and investigation. The heat units obtainable from steam having a given velocity drop can easily be ascertained, and having regard to the fact that steam from efficient modern turbines contains a considerable percentage of moisture, it would appear that this energy produces a drying effect on the exhaust steam, rather than a superheating one.

It is generally agreed by all those interested in condensing plant problems that there are still many improvements to be effected and many interesting questions to be solved.

For W. H. ALLEN, SONS AND CO., LTD.,
Bedford, December 4th. HAROLD G. ALLEN.

BELT DRIVES.

SIR,—Although my memory cannot carry me back to the days of which Mr. Pardoe speaks, I can confirm his statement as to the antiquity of the jockey pulley drive, which seems to have been resuscitated under the name of the "Lenix" drive. I well remember that in the old engine shops of Ferranti, Ltd., at Hollinwood, there was a row of lathes on a gallery driven from a line shaft running along the edge of the gallery, slightly above and behind the lathes. I do not think the centre of the line shaft can have been more than 3ft. from the centres of the lathe spindles. There were no countershafts, a leather chain belt, kept taut by the weight of a broad jockey pulley on a radial arm, connecting the belt cones. To stop a lathe, the operator just swung the jockey pulley up, out of contact with the belt, when the latter was at once rendered too loose to drive. He did the same thing before shifting the belt on to another cone. The arrangement was certainly an old one in November, 1901, when I first saw it. The workmen were perfectly content with it, and as it saved countershafting, belting and striking gear, rendered the line shaft accessible and did not interfere with the light, it seemed to me worthy of more general adoption. There can be no doubt that a similar drive can be adopted by anyone who wants to do so, without regard to any foreign patents. M.I. MECH. E.

December 4th.

SIXTY YEARS AGO.

THE colliery disaster which occurred at the Hindley Pit, Wigan, towards the end of November, 1868, and which resulted in the deaths of over sixty persons, resembled, according to a leading article in our issue of December 4th of that year, "hundreds of others which have happened before and will unfortunately occur again." At this distance of time we might criticise the calm acceptance as perfect of any system of mine ventilation which depended upon the use of a furnace at the foot of the up-cast shaft. That system had been, and continued to be, practised in most mines. In the case of the Hindley Pit disaster, it undoubtedly aggravated the loss of life, for after the explosion the ventilation current was reversed, and many of the victims perished, not by the explosion, but by the fire and fumes brought into the workings from the furnace. We at least were alive to the dangers of the furnace system of ventilation, and, not for the first time, urged the use of mechanical means such as might be rendered available by the installation of a Guibal fan or a Harden steam jet ventilator. We did not, however, on this occasion dwell as severely as we might have done on defective systems of mine ventilation. We were largely concerned with another aspect of the Hindley disaster. It seems that shortly before it occurred, Mr. Negretti, of Negretti and Zambra, prophesied in the columns of the *Daily News* that colliery disasters would probably occur within the next few days. Mr. Negretti based his argument on the very low barometric pressures recorded on November 22nd and 23rd, and he hastened to issue his warning. On examination, we found that while the prophecy had been fulfilled, the grounds on which it was based were entirely at fault. The pressure on the days named fell to about 28·97in. The explosion, however, did not occur until a few days later. On the day of the disaster the barometer in the mine actually registered 30·6in., and on the day before it had stood at 30·5in. If anything, the mine should, under these circumstances, we pointed out, have been in a particularly safe condition, for, according to the theory underlying the prophecy made by Mr. Negretti, the gas in the pockets and cracks in the coal should have leaked out during the period of low atmospheric pressure, so that when the high pressure period arrived later, any gas remaining in the pockets should have been more than usually well held therein by the air pressure outside. We therefore maintained that the theory on which Mr. Negretti was working was not proved. For many years afterwards, however, that theory continued to be believed. It is only within recent times that periods of high pressure and not periods of low pressure have come to be regarded as dangerous to mining operations. The modern view of the subject is that extra pressure on the earth's surface above the mine opens up the cracks and fissures below ground, and allows the gas to escape from them. Under low superincumbent pressure, the cracks tend to close up. The Hindley disaster of 1868 certainly provides much evidence in favour of the modern view.

ALDWYCH AUTOMATIC SUB-STATION EQUIPMENT

THE GENERAL ELECTRIC COMPANY, LTD., WITTON, ENGINEERS

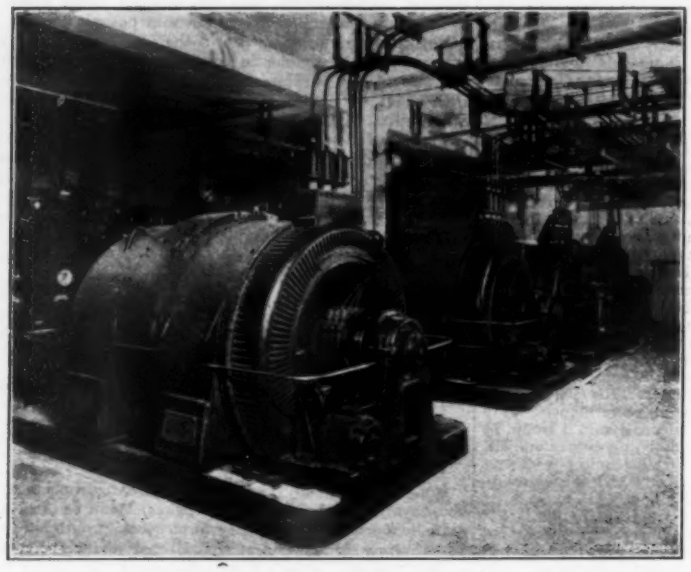


FIG. 1—750 kW MOTOR CONVERTERS

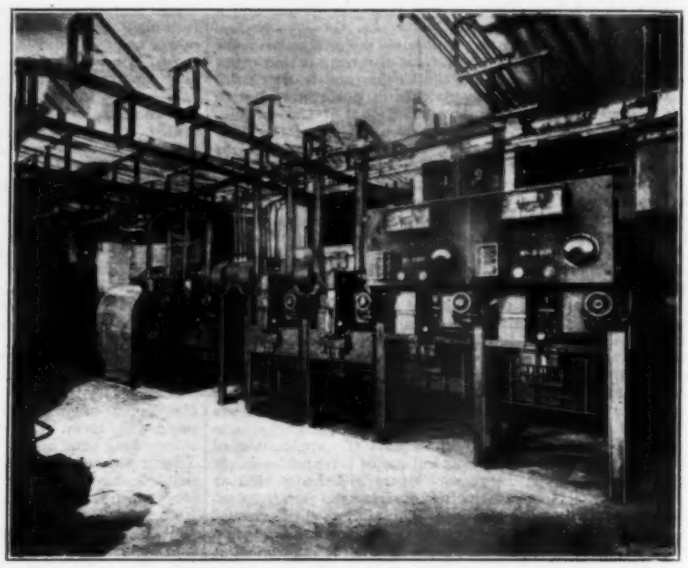


FIG. 2—H.T. METAL CLAD SWITCHGEAR

A New Automatic Sub-station in Aldwych.

THE Charing Cross Electricity Supply Company, Ltd., traces its history back to the year 1882, when Messrs. A. and S. Gatti installed a small electric generating plant for the purpose of lighting their Adelaide Gallery Restaurant. To-day the load of the undertaking is no less than 35,000 kilowatts, and the early direct-current stations that were set to work at Bull Inn-court, Maiden-lane, and in Lambeth, have, of course, long ceased to exist. In accordance with modern practice three-phase alternating-current is now generated, but distribution is still carried out on the three-wire direct-current system. Needless to say, this necessitates the provision of converter sub-stations in various parts of the area of supply, and some time ago we described the company's sub-stations in Soho-square.

Another new automatic sub-station has now been put into operation in the basement of Aldwych House. The plant consists of four 750-kW motor converters made by the General Electric Company, of Witton, Birmingham, which also supplied all the other electrical equipment, with the exception of the switchboard controlling the outgoing direct-current feeders, which was made and erected by the supply company's engineers. As the space available in the basement of Aldwych House was limited, viz., 52ft. by 48ft., special attention had to be paid to the selection and arrangement of the plant, which, as we have said, takes the form of four motor converters. Normally the sub-station is controlled, either completely automatically, or on the remote control system from the company's generating station at Shorts' Gardens. The control gear consists of metal-clad oil-circuit breakers—see Fig. 2—for controlling the incoming H.T. supply, starting and synchronising panels, a direct-current control board, and relay panels and outgoing feeder panels, which give a 200-230 volt direct-current three-wire supply. The 11,000-volt 50-cycle 3-phase supply is obtained from the London Power Company *viâ* Shorts' Gardens.

Under remote control conditions, the automatic relays for starting and stopping are put out of action, whilst in the case of emergency the plant can be manually operated. When the station is controlled automatically one of the machines will start up when the bus-bar pressure falls to a certain value below the normal value, and remains at that value for a predetermined time. The machine synchronises itself and switches in automatically on the direct-current side, and when it has been working at about 90 per cent. of its full load for a predetermined period, or in the event of its failing to take up the load, a second machine will start up and take up load. Similarly the third and fourth machines come into operation when the local conditions call for their assistance, whilst as the load falls the machines shut down in the same sequence as they started—that is to say, the first machine to start up will be the first to shut down, and as the machines stop, the switchgear is automatically reset ready for starting up again. Protection is provided against all faults that may develop in the machines and their controlling switchgear, or in the system to which the converters are connected.

Remote control from Shorts' Gardens is carried out by pilot wires. By means of this remote control system one or more machines may be started up or shut down, and the position of the switchgear and synchronising contactors of each machine may be determined. The load on each machine and the voltage between the outers and middle wire can also be determined, and the setting of the automatic voltage regulating relay can be adjusted. It is also possible to delay the closing of the direct-current circuit breakers until the desired number of machines are running, when all their breakers can be closed together. At Shorts' Gardens it is also possible to ascertain whether the automatic ventilating fan is running, and means are provided for indicating the lock-out of any machine.

The incoming supply is provided by two 11,000-volt feeders, each of which is brought to G.E.C. high-tension metal switchgear, which incorporates many new and interesting features, not the least of which is the neat appearance of the units, which are shown in Fig. 2. The high-tension supply to each of the four motor converters is also controlled by metal clad switchgear, and in this case the oil-circuit breakers are motor-operated. A special feature of this metal clad switchgear is the method by which the breaker is raised or lowered. Four chains are attached to the tank, and the raising and lowering operations are carried out by means of a capstan handle. The breaker is held in the raised position by a bar under the tank, thus eliminating the danger of the tank being lowered, leaving the breaker plugged in. The trip gear mechanism is interlocked in such a manner that, should an attempt be made to lower the breaker while the contacts are closed, it will be tripped automatically immediately the lowering operation is begun, and this interlock also prevents the circuit breaker from being raised while the contacts are closed. Another important feature is the method of bus-bar selection, which is accomplished by an ingenious plug contact assembly known as a "revolving turret," and with this arrangement the entire process of changing from one set of bus-bars to another only occupies a few minutes.

The 200-240 volt low-tension switchboard, which was also manufactured and installed by the General Electric Company, consists of 13 panels, the centre panel being a master control panel. There are three panels for each machine, and on the panel that controls the direct-current output there are circuit breakers and metering equipment, whilst the third is connected with relay controls, &c. The outgoing direct-current feeders are controlled by the switchboard, manufactured and erected by the Charing Cross Electric Supply Company's engineers. In all, there are sixteen panels, each fitted with circuit breakers, with overload trips and metering equipment.

In order to maintain the temperature of the air in the sub-station at a definite value, a large Davidson fan has been installed, which automatically starts up and continues to run until the last machine is shut down, whilst an air filter, installed by the Premier Cooler and Engineering Company, insures that all the air entering the sub-station is free from dust.

CATALOGUES.

CELLACTITE AND BRITISH URALITE, Ltd., Higham, Kent.—Particulars of "Cellactite" roofs.

HEAD, WRIGHTSON AND CO., Ltd., Noton-road, Stockton-on-Tees.—1928 booklet on chimneys and tanks.

HOLMAN BROTHERS, Ltd., Camborne.—Summarised catalogue of "Holman" compressed air and mining plant.

EDGAR ALLEN AND CO., Ltd., Imperial Steel Works, Sheffield.—"The Edgar Allen Mine and Quarry Book."

CROFTS (ENGINEERS), Ltd., Bradford.—Particulars and a sample of Crofts "Sure-Grip" endless V-rope drive.

LACY-HULBERT AND CO., Ltd., 91, Victoria-street, S.W. 1.—List P7 of portable air compressors, petrol and electric driven.

ALFRED HERBERT, Ltd., Coventry.—Tenth edition of the firm's catalogue of machine tools and machine shop accessories.

C. M. HILL AND CO., Coventry House, South-place, E.C. 2.—Publication No. 241 on "New Century" light Diesel locomotives.

THE BRITISH ALUMINIUM COMPANY, Ltd., Adelaide House, King William-street, E.C. 4.—Booklet, "Aluminium Foundry Practice."

FRANCIS SHAW AND CO., Ltd., Bradford, Manchester.—Catalogue H7 of hydraulic presses for moulding bakelite, ebonite and plastic materials.

CAMPBELL AND ISHERWOOD, Ltd., Bootle, Liverpool.—Catalogue E.P.T. 10, illustrating and describing S.D.L. refrigerating and ice-making plant.

RANSOMES, SIMS AND JEFFERIES, Ltd., Orwell Works, Ipswich.—Brochure illustrating the various types of omnibus bodies supplied by the firm.

RUTH'S STEAM ACCUMULATORS, Ltd., Africa House, Kingsway, W.C. 2.—Several of the firm's latest pamphlets dealing with steam storage.

J. AND F. HOWARD, Ltd., Bedford.—A new publication on the Howard internal combustion locomotive, giving particulars of its construction and capabilities.

PETTERS LTD., Westland Works, Yeovil.—Publication No 1542, describing some typical machines in which "Petter" oil engines supply the motive power.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Rail Rates Rebate.

THE market is endeavouring to find a new business level as the result of the effect upon prices of iron and steel of the reduction in transport rates, which became operative on Saturday last. On 'Change in Birmingham this week Midland and Staffordshire industrialists tried to determine what readjustments would meet the case. Producers and consumers seemed unable to arrive at agreement as to their respective share of the relief afforded, and as to how running contracts should be affected. Those who occupy an intermediate position were warned by both sides that they will be held responsible for any part of the rebate which is paid over to them by the Railway Clearing House. It appears certain matters will take some little time to adjust, and, meanwhile, judging by the amount of business placed at to-day's market in Birmingham, business will be held up. Apart from the indefinite position regarding the rebate, there is a general disinclination amongst consumers to add largely to commitments, with the year so near its close. However, once equilibrium is restored, with cheaper internal transport, and the prospect of a concurrence of favourable factors to reinforce a lighter load of rating, we may, it is thought, anticipate a turn for the better in the heavy industries of this area.

Raw Iron.

Pig iron prices are rather easier, mainly owing, no doubt, to the fact that consumers, realising that blast-furnacemen are now getting State relief on their fuel, have stiffened their attitude, and flatly refuse to buy unless some concession is granted. Midland blast-furnacemen, all this week, have been arguing that they cannot, as suggested by coke suppliers, go halves with them or fall in with the wishes of users of raw iron and hand over part of the rebate to them. The plea of smelters that present selling prices do not pay them falls upon deaf ears, and the consumers hammer it home that as the blast-furnaceman is getting cheaper raw material he cannot in all conscience expect as much for his product. At the moment matters appear to have reached a deadlock, and negotiations are for the time being held up. It is thought that smelters may endeavour to maintain current rates by further reduction of output, as nothing short of that will force consumers to buy at to-day's rates. Competition for orders cannot be suppressed in an unstabilised market, however, and the stout protestations by pig iron producers have not entirely succeeded in upholding values. Some furnaces are said to have accepted orders at a shilling or so below the quotations generally ruling. On 'Change in Birmingham to-day—Thursday—Northamptonshire forge iron could probably have been bought at £2 11s. or a little over. Derbyshire forge showed little sign of declining, but consumers asserted they could buy at a rather better price than at the £2 16s. quotation which has recently defined the position. Prices of foundry numbers have in a few cases been shaded. Northamptonshire No. 3 is reported to have been sold at £2 15s. 6d. This low price would certainly not be entertained by a good many furnacemen. Derbyshire No. 3 foundry material is generally quoted at £3 at furnaces, but some business is claimed to have been placed at about 1s. less. It will take some little time for the market to settle down to the new position, and although prospects are considered brighter, it is not thought any revival in pig iron buying can be looked for before the turn of the year. Neither is it considered that the prospect of additional blast-furnaces being relighted in the Black Country is brought appreciably nearer by the rail rates relief. Nor is any material effect on the market to be expected, for most of the pig iron now being made in the area goes direct into use in works which are affiliated with the furnaces, and does not come to the market at all. The crude material for the iron foundries which are so numerous in this neighbourhood, and for

the forges which still survive, is drawn mainly from outside, Derbyshire and Northamptonshire being the principal sources of supply. Output from these sources is more than sufficient to satisfy the needs of consumers. Competition in pig iron with the Cleveland district, which was a feature a few weeks ago, has practically disappeared. Moderate sales of hematites are reported, and East and West Coast products command roughly the same figure, namely, £4 5s. to £4 5s. 6d. for mixed numbers, delivered Midlands.

Steel.

There has been no improvement of note this week in the steel department. In the heavy steel departments there is a good deal of unemployed resources, structural engineers not being in a position to give out bulk business. Prices of angles and joists are stationary at £7 17s. 6d., and ship, bridge and tank plates at £8 12s. 6d., with the customary rebates to users of English material only. Industrialists, who have been relying on continental supplies of finished material, complain of delayed delivery. With less price disparity an increasing number of consumers are finding it more advantageous to buy at home. Continental offers of joists have been received in Birmingham this week, but the prices are very high, and consequently unattractive to British users. Nevertheless demand for native material remains light. Rollers of small bars keep reasonably busy. Some of them have not yet exhausted their stocks of continental billets bought when prices were low. Business is coming in on a moderate scale for bars and strip. Offers of Belgian bars have this week been received for delivery towards the end of January. The price, however, does not encourage acceptance, and home producers will continue to command a considerable proportion of the trade so long as they can maintain the basis at around £7 15s., with possibly a small cut for lines of more than ordinary bulk. English and Welsh billets are offered at £6 7s. 6d. upwards, and a healthy tonnage of them is now being used in the rolling mills owing to the scarcity of imported semis. Steel scrap is in moderately good demand. Values are unchanged.

Finished Iron.

The Staffordshire finished iron trade remains quiet, business having further fallen off during the past week. Employment is fairly regular at the marked bar mills, and the £12 standard, which has been in operation since the beginning of April, is upheld. Meagre business is being done in Crown and common bars. Competition is unabated, and quotations generally show no change. A little more Belgian No. 3 iron for nut and bolt making has been on offer this week, and now that the German labour trouble is at an end an increase in shipments of this material to the Black Country is anticipated. There is no alteration in the position in the strip branch. Makers of wrought iron gas tube strip are still able to command £10 15s. to £10 17s. 6d. for their output.

Galvanised Sheets.

Galvanised corrugated sheets of 24-gauge are firm at £13 10s. to £13 15s., according to specifications. The works are well occupied, and makers are quoting for delivery in the New Year. Lighter gauges are in good request for export at recent rates. Motor engineers are taking fairly good and regular supplies of black sheets and tonnages tend to become larger.

Midland Metallurgists' Dinner.

The Co-ordinating Committee of the Staffordshire Iron and Steel Institute, the Birmingham Metallurgical Society, and the Birmingham Local Section of the Institute of Metals, held its third annual dinner at the Queen's Hotel, Birmingham, on the 1st inst. Mr. P. Jump, A.M.I. Mech. E., President of the Staffordshire Iron and Steel Institute, presided over a large attendance. The Lord Mayor—Councillor W. Byng Kenrick—in proposing a toast to the Co-ordinated Societies, said that whatever might have been the vicissitudes of trade in the past, and however depressed were the iron and steel trades to-day, it was some satisfaction to know that the trades had been equally depressed on previous occasions. Grievous as their present position might be, if past history taught them anything, it did supply some ray of hope that, by applying the powers of scientific observation and skill to these problems, they might yet come out of the depression and still remain the very important foundation of the prosperity of Birmingham and the whole area of South Staffordshire. Continuing, the Lord Mayor said that all their industries were very important, and their success had been founded on the ability of the leaders of those industries to add something each in his own day and generation to the collective knowledge with regard to the methods of handling these metals. It was that spirit of co-operation in industry both with regard to bringing together the collective wisdom of the trade and the collective interests in the trade, which would overpower whatever elements of discord or disunion there might be in the trade. It was these two things that alone could help them to overcome such difficulties as were encountered in trade and industry at this time. The chairman, in reply, said that industry, if it were to be successful, must clearly indicate to the technical schools and colleges the class of worker it required in any special industry. They were the representatives who ought to form a contact between industry and education. He believed that was one of the ways in which members of societies, such as their own, could be of real value to industry at the present time. Mr. P. J. Hannon, in submitting the toast of "The Birmingham and Midland Metallurgical Industries," said the research and investigation these co-ordinating societies were engaged in were of profound value to the nation for new processes. Mr. S. H. Holden, chairman of the Midland Section of the Institution of Electrical Engineers, replied. Mr. A. R. Page proposed the toast of the "Guests and Kindred Associations," Dr. W. Rosenhain, President of the Institute of Metals, responding. Mr. A. R. Page, President of the Birmingham Metallurgical Society, presented the Society's medal to the past President, Mr. W. R. Barclay.

Birmingham and Rating Reform.

Industrialists in Birmingham have been keenly interested in the probable effects of the Government's rating proposals, and they learn with pleasure that the city stands to gain thereby. On the basis of present estimates, the city will lose £641,300 in rates, plus £256,842 in grants—£898,142 in all, or, in round numbers, £900,000. In the first quinquennium Birmingham will have no need to invoke the assistance of the Government guarantee of a minimum gain of 1s. per head, for the normal application of the scheme will bring the city a new grant of £975,000, which means a gain of 1s. 7d. per head, or the equivalent of a rate of 3¼d. The gain in the second five-year period should represent a trifle over a twopenny rate, and in the third a rate of seven-tenths of a penny. As to the fourth period—the years 1945-1946 to 1949-50—it is estimated that there will be neither gain nor loss. All this is to the good of Birmingham, and, furthermore, it is felt that industrial development cannot help but be expedited and facilitated by the removal from local industry of 75 per cent. of the burden of local rates.

Ironworkers' Wages.

Wages of ironworkers in this area, which are regulated by sliding scale under the Midland Iron and Steel Wages Board, are to remain unaltered during the next two months. They now stand at 27 per cent. above the puddling base rate of 13s. 6d.

Engines for Motor Boats.

A new venture of Morris Motors, Ltd., namely, entry into marine motoring by the production of an engine suitable for the propulsion of launches and small motor cruisers, is announced. The engine will be rated at 12|23 H.P., and will be sold, complete with full electrical equipment, at £100. The most important components of the Morris marine motor will be interchangeable with those of the same make of car engine.

Hereford Firm to Construct Transmission Towers.

It is understood here that the steel transmission line towers required for Part II. of the South-East of England electricity scheme will be built by Messrs. Painter Brothers, of Mortimer-road, Hereford. The contract is reported to have been placed by Callender's Cable and Construction Company, Ltd., the main contractors for the construction of the 132,000-volt transmission lines south of the Thames.

Birmingham Motor Order.

Garner Motors, Ltd., of Birmingham, has received an order from the General Electric Company, Ltd., of Kingsway, London, for a fleet of 2½-ton chassis, to be fitted with special bodies with detachable tilt tops. The vehicles will be adaptable for the transport of goods or of employees of the company.

Cannock Collieries Make a Profit.

For the first time for many months the Cannock Chase coal industry showed a profit on coal produced in the past month, the gain being 5·84d. per ton. The accumulated deficit now stands at £2,604,289. Miners' wages for December will continue at 42 per cent. on the 1911 wage basis, although the ability of the industry to pay, based on the proceeds in August, September and October, is only 17·84 per cent.

Canal Bridges.

The Wolverhampton Corporation, in the interests of industry, and to remove present limitations relative to transport vehicles using canal bridges, which at date are considered unsuitable or unsafe for heavy traffic, has decided not to await the new legislation, to which I referred in a recent letter, but to take immediate action in respect of several arterial bridges, and with this object it has entered into an agreement with Birmingham canal navigations under which, in consideration of a sum to be settled by arbitration, the Corporation has undertaken to take over two such bridges. The inquiry has already been held, and I am given to understand that as soon as the award is announced the Corporation proposes to put in hand the work of reconstruction. That the local authorities in the area referred to are determined to do all they can in this important matter, is evidenced by the fact that they have already made arrangements for the reconstruction of three other bridges.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Rates and the Revaluation.

THE revaluation of property for rating purposes under the 1925 Act, the object of which was to secure uniformity throughout the country, will result in few startling changes in Manchester, for the reason that a revaluation of property in the city was carried out in 1921. The effect on the assessment of industrial premises because of the removal of certain classes of machinery which were formerly rated from the official valuation list, has been a loss to the city's revenue equivalent roughly to a 2d. rate. Under the De-rating Bill now before Parliament, it is estimated that the 75 per cent. relief which, it is proposed, would be granted to certain industries would involve in the case of Manchester the sum of about £400,000.

Manchester-Altrincham Electrification Scheme.

An unofficial report during the past few days is to the effect that a beginning will be made early in the New Year with the work of electrification of the London, Midland and Scottish and the London and North-Eastern joint railway line between Manchester and Altrincham, a distance of about 8 miles, and an official announcement to that effect is forecasted within the next few days. The scheme was sanctioned early in September, the estimated cost being in the region of £500,000. Additional interest is being taken in this matter by reason of the fact that it is believed that the scheme will ultimately form but a portion of a much larger one affecting railway transport between Manchester and an important area in Cheshire.

Back to Full Time.

The resumption of full-time working at the locomotive and carriage works of the London, Midland and Scottish Railway Company from last Saturday has been welcomed in the Manchester district. Following as it does upon the recent official announcement that in the interests of economy a large number of men were to be stopped in various departments, the news has been particularly pleasant at Crewe, where 8000 men employed in the shops are affected. In the case of the carriage works at Newton Heath, Manchester, about 2000 men will revert to full time, and a large number also at the locomotive works at Horwich, where the five-day week has been in operation since about the middle of June. With regard to the last-mentioned works, the shops will be closed for holidays, on Monday, Tuesday and Wednesday during Christmas Week, and on Monday and Tuesday in the following week.

Electricity Plant for £113,000.

Alderley and Wilmslow (Cheshire) Urban District Councils decided at a meeting on Tuesday, December 4th, to complete the purchase of the whole of the Alderley and Wilmslow Electric Supply Company's undertakings on December 25th at a purchase price of £113,000. Members of the Joint Electricity Board were appointed to take over the control of the works.

Automatic Telephones.

It is expected that the first of the new automatic telephone exchanges for Manchester will be working by the end of next year or early in 1930. Other automatic exchanges will also be opened as part of a system to serve the area within a 7 miles radius of the centre of the city.

Preston Power Station Extensions.

Preston Corporation Electricity Committee has recommended the acceptance of a tender of £46,000 submitted by the English Electric Company, Ltd., for carrying out work at the power station to increase the capacity of the plant from 50,000 to 60,000 kilowatts.

New Tramways Manager.

Mr. R. S. Pilcher, who since 1918 has been in charge of the Edinburgh Corporation transport department, has been appointed by the Manchester Corporation Tramways Committee as general manager of the city's tramway system, at a salary of £2000. Born in Liverpool, Mr. Pilcher received his early training as an electrical engineer in Canada with the Montreal Street Railways Company. He returned to Great Britain to take up the position of general manager to the Aberdeen Corporation tramways, and in 1918 went to Edinburgh.

Non-ferrous Metals.

Firmness has been a conspicuous feature of pretty well every section of the non-ferrous metals market during the past week. Up to the close of business last week-end tin had registered a slight advance after its spectacular upward flight referred to in this column a week ago. During the early days of the present week, however, signs of reaction have been in evidence, and although they are not particularly marked at the moment of writing, they have been sufficient to wipe out the additional rise during the later days of last week, values on balance for cash metal being about 2s. 6d. a ton lower than at last report. In view of the steady increase in home stocks of tin there is much speculation as to how long the present firmness will continue without a break. Copper has attracted a fair amount of attention, but here, again, the highest values were not maintained in the early days of this week, although standard brands are still about 5s. a ton dearer than a week ago; best selected copper has been advanced by 10s. but other refined descriptions are steady and unchanged. Spelter has been the subject of very active buying during the week, and this has been reflected in the price position, a further substantial advance having occurred. A similar stimulus has influenced the lead section, a rise of 10s. to 12s. 6d. a ton following upon the display of greater interest in the metal.

Iron and Steel.

A definite tapering off of business activity has been in evidence this week. How far this is due to seasonal influences and how far to unsatisfactory consuming conditions, is not easy to define, though both are undoubtedly exercising their effect. Foundry iron has sold very slowly, and chiefly in small parcels. Values in this section have not appreciably weakened, but both Derbyshire and Staffordshire irons have been disposed of at prices which are a few pence below the levels that were current a week ago, quotations being at 67s. 9d. and 67s. to 67s. 6d. per ton respectively, including delivery Manchester or equal distance. Not much business is being done in other brands, but prices of these are not quotably changed, Cleveland remaining at about 79s. per ton, Scottish irons at from 87s. 6d. to 90s., and hematite at 82s., all delivered to works in this district. Firmness continues to characterise all varieties of steel materials, notwithstanding the comparatively poor bookings that are being effected on this market. The position of constructional engineers is little better than it has been during the past month or so, and there are few indeed that are not anxiously awaiting additions to their order books. The call for steel from this direction is therefore of limited extent, and not much new business is being placed for boiler plates. Even small rolled bars appear to be moving off in smaller quantities than before, though values of these keep very firm at from £8 to £8 2s. 6d. per ton, according to quantity. Boiler

plates are quoted at £9 10s. to £9 15s.; general plates at £8 12s. 6d.; sections at £7 17s. 6d.; and large bars at £8 17s. 6d. Except for a slight weakening in semi-finished products, the German lock-out settlement has had little effect on foreign steel prices, and consumers generally, so far as important buying is concerned, are content to hold their hands.

BARROW-IN-FURNESS.

Hematite.

Business in pig iron continues to be steady, and the demand is maintained. A certain amount of trade has been possible, owing to the dispute in Germany, but now that the trouble there is at an end, it is possible that this business will shrink, and that the market will become normal again. That will not happen immediately, however, as it is possible that certain orders placed will cover a period for delivery. The stocks are down in the district, and the output at present is being cleared. With the steel works idle at Barrow, the local demand is affected, but there are hopes that the rail departments will soon be at work again. A firm amount of business is being done by producers in the district in special qualities, and foreign business continues. The iron ore trade is about the same, and none of the local mines is very active. It will require more furnaces in blast to improve the local trade. Foreign ore is arriving in steady, but not excessive tonnage. The steel trade continues quiet, and the Barrow steel departments are still idle. They may restart in a week or two, but nothing official is known yet. Orders are held, but they do no cover more than six weeks' to two months' running. In the meantime, the rail mills, &c., are being overhauled. Hoops are in regular demand, and the works are fully engaged.

SHEFFIELD.

(From our own Correspondent.)

The State of Trade.

GENERALLY speaking, there is no improvement to report in the steel trades of Sheffield and district. While there is still considerable activity in the lower grades of open-hearth steel, the inquiries with regard to new business show a falling tendency. In hard basic and acid billets, the position is far from satisfactory. There is some progress to note in specialities, but in most of the ordinary lines changes are in a downward direction. It would probably be correct to say that in at least half of the city's staple industries December has opened badly, and, in view of the approach of stocktaking, no turn for the better is expected this year. The basic furnaces at Templeborough are still working almost full time, and a basic furnace has been gassed at Fox's works, Stocksbridge. On the other hand, production has been reduced at the Ickles Works of Steel, Peech and Tozer. A state of activity is maintained at the United Strip and Bar Mills and the Templeborough wire rod mill; and at Park Gate the melting plant is running up to capacity. Most departments of Vickers-Armstrongs' works are busy, and the Tinsley Works of Metropolitan-Vickers are actively engaged on the construction of powerful electric locomotives for the Indian and other overseas railways.

Railway and Other Orders.

The sluggish condition of work in the railway steel departments continues, and the outlook does not improve. The home railway companies are cutting down specifications to a very low level, the colliery companies are placing very few orders for wagon building or repairing, and work from abroad is only on a small scale. In consequence, the axle, tire, and spring departments are very slack, and are suffering from periods of idleness. The decision of the Southern Railway Company, announced this week, to give a trial to steel sleepers, is of great interest, and holds out a welcome promise of help to the steel trade. The initial order placed by the company, which is for the substantial quantity of 70,000 sleepers, equal to 5000 tons of steel, has been given to a Sheffield firm—the United Steel Companies, Ltd.—but does not affect the city directly, as the work will be done at Workington, where it will be spread over two years. The value of the contract is £52,000. The number of sleepers used in this country annually is 4,000,000, so that the adoption of steel to anything like a general extent would be of great benefit to the heavy side of local trade. The firm of Jno. Hy. Andrew and Co., Toledo Works, has more orders on hand at present than has been the case for years. It has recently obtained an order for plough steel wire rods, valued at between £10,000 and £12,000, from the United States of America, and it is stated that an order for similar material, of about half that value, was booked earlier in the year. Vickers-Armstrongs, Ltd., have received an order from Lever Brothers, Ltd., for two pairs of steel lock gates for their new dock at Bromborough.

Wire and Wire Rope.

Prospects of better times in the wire and wire rope trades are afforded by the formation of a combine of nearly all the makers of rope wire, among whom are several Sheffield firms. For some years there has been a serious price war between the combined rope manufacturers and the outside firms, which has cost makers a lot of money without increasing the volume of trade, and has affected the makers of rope wire. It is understood that the fight has now come to an end, and that matters are to be so arranged that the firms concerned shall be able to earn living profits. So far as the home trade, at any rate, is concerned, foreign competition in wire ropes, and the wire of which they are made, is not serious, and this country also has a considerable export trade. During the first ten months of this year, our exports of rope and cable amounted to 20,879 tons, the value of which was nearly £1,000,000. A substantial order for rope wire for Russia was recently booked by a Sheffield firm, and several firms have lately been busy on work for the United States and other export markets.

Spanish Tariffs.

Satisfaction is felt in Sheffield at the announcement that the Spanish Council of Ministers has decided to prolong the existing customs tariff for another year. The proposed increases threatened to have a very serious effect on Sheffield, especially as regards files, and a strong agitation has been raised against them. The Government decision referred to does not, however, remove all difficulty. All the Spanish treaties with foreign powers have been denounced with a view to introducing the modifications and increases proposed in the new tariff, and it is feared that the present rates may not be maintained in view of the lapsing of rates under treaties at present in force.

Cutlery and Plate.

There is not much change to report in the state of the cutlery and plate industries. In the majority of cases, orders for the Christmas season trade were completed two or three weeks ago, and some firms have now little work on hand. Late orders are not numerous, and are confined to a few firms. There is still a fair demand for cutlery and plate of the highest quality, and the cheap trade is maintained at a high level, but the demand for medium class goods is very moderate. The determination of the Cutlers' Company to protect the trade name of Sheffield against unfair marking was again shown last week, when a prosecution was brought at Oxford against a well-known bazaar firm, for selling knives of very inferior quality which were marked "Best English cutlery, Sheffield." The defendants, who pleaded guilty, said the knives were ordered from a reputable manufacturer in Sheffield, but none of the quality had been ordered since December of last year. They were fined £5 and £75 costs. The tool trades are still only moderately employed, and makers report that orders are principally for small quantities.

Hull's Level Crossings.

For thirty years the abolition of the level crossings in Hull has been advocated, that city having more main thoroughfares which are crossed by railways than any other city in the country. It has been estimated that the abolition of the crossings would save the Corporation Tramways Department £10,000 a year, and the general gain in facilitating traffic would be very large. The agitation has gained strength during the last few years, and there is now a prospect of the matter being tackled in earnest. It will involve a great amount of work, of a costly character. The total expenditure is estimated at £1,217,000, of which the London and North-Eastern Railway Company has promised to provide £100,000. It is proposed that the rest of the money shall be found by the Corporation, and towards its share the Unemployment Grants Committee of the Government has offered to give 75 per cent. of the sinking fund and interest for fifteen years, or half the loan period. This offer, it is stated, represents a contribution of £563,000 towards the total expenditure. The Finance Committee has recommended the Corporation to accept the offer.

A Historic Steamer.

It is announced that Thos. W. Ward, Ltd., of Sheffield, have purchased, for breaking-up purposes, the steamship "Reindeer," one of the best known Weymouth–Channel Island steamers, owned by the Great Western Railway Company. The "Reindeer" carried troops during the war, served in the Mediterranean, and was one of the first vessels to enter the Dardanelles when the Turks surrendered.

NORTH OF ENGLAND.

(From our own Correspondent.)

More Work for Shipyards.

THE revival in the shipbuilding industry on the North-East Coast, to which I referred in my letter last week, continues. Further orders have since come forward, and several of the yards are now assured of active operations well into next autumn. The most important order is that secured by Mr. T. E. Thirlaway, chairman of Swan, Hunter and Wigham Richardson, Ltd., Wallsend-on-Tyne, who has just returned from Canada. It is understood that the contract is for about ten grain-carrying steamers for the Canadian Lakes. In the aggregate these orders, which are for vessels 250ft. in length, amount to a substantial tonnage, and the work will be distributed among the firm's yards on the Tyne, the Wear, and the Clyde. The Furness Shipbuilding Company, Haverton Hill-on-Tees, has been commissioned to build a vessel of 10,000 tons for British owners, and among other orders placed are three cargo vessels with the Northumberland Shipbuilding Company, Howdon-on-Tyne; three cargo vessels with Chapman and Sons, Newcastle-on-Tyne; two cargo steamers with W. Pickersgill and Son, Sunderland; and one cargo vessel with W. Gray and Co., West Hartlepool. Things certainly seem to be taking a turn for the better in the shipbuilding industry. At the same time, too much importance must not be attached to the orders that have been received lately, for, although there can be no doubt that there is a strong demand for new ships at the present moment, the prices at which they are being built leave a very small margin of profit. Sooner or later prices are bound to stiffen, and then orders may fall off.

Cleveland Iron Trade.

The disturbed conditions on the Continent have assisted to strengthen the situation in the Cleveland pig iron trade. Producers have fairly substantial contracts arranged, and prospects are brighter than they have been for a long time past. Growing requirements of consumers encourage the hope that ironmasters may shortly feel justified in re-kindling idle blast-furnaces, of which there are no fewer than 64 on the North-East Coast, the number in operation being 31, or less than half the number in pre-war normal times. The bulk of the output of Cleveland pig iron is consumed by makers at their own foundries, and the limited quantity available for the open market is readily taken up. Fixed prices have been steadily maintained for many months, despite efforts of customers to break them, and the fact that Midland iron has been underselling the products of this district in areas hitherto supplied almost entirely from Cleveland. No. 1 foundry iron is 68s. 6d.; No. 3 G.M.B., 66s.; No. 4 foundry, 65s.; and No. 4 forge, 64s. 6d.

Iron and Steel Exports.

Whilst the domestic consumption of pig iron, manufactured iron and steel is on the upgrade, the expansion does not yet extend to the export trade, and the shipments from the Cleveland district during November were actually lower than in the preceding month. The reduction, however, amounted to no more than 8269 tons, and may be accounted for by the delays to shipping owing to the gales, and the fact that there was one fewer working day in November than in October. The exports fell from 85,370 tons in October to 77,091 tons in November, but the latter figure was still about 10,000 tons in excess of the September exports. Foreign shipments of pig iron keep fairly steady at about 8500 tons per month, but since July last there has been a regular contraction in the volume of the pig iron deliveries from Cleveland to Scotland, and last month these fell to only 5533 tons, the smallest total of the year. This, of course, is entirely due to the keen competition of the Midland ironmasters. A fall of about 3500 tons in the shipments to India, and 1100 tons in the South American trade, largely accounts for the slight decline in the aggregate shipments of manufactured iron and steel. But a month's total of 61,733 tons is well above the average for the year, and as domestic consumption has improved the steel works are busier than for some time past. On the other hand, imports continue to diminish. During November they totalled 13,496 tons, as compared with 14,093 tons in October and 17,008 tons in the corresponding month of 1927.

Hematite Pig Iron.

Continental demand for East Coast hematite pig iron is somewhat quieter, but combined with current home requirements it is still sufficient promptly to absorb the restricted make, and, as there are now next to no stocks, scarcity is rather acute. Gjers, Mills and Co., Middlesbrough, are expected to recommence the manufacture of hematite at their Ayresome Ironworks early in the New Year. In this branch, makers have no arrangement definitely fixing prices, and terms on which business is put through vary considerably, but bargaining usually results in sales at the equivalent of about 71s. for ordinary qualities.

Ironmaking Materials.

There is very little business passing in foreign ore, but merchants are taking a firm stand, and are assisted in their attitude by the stiff state of the freight market. Consumers continue to hold off, but sellers are emphatic in their declaration that full market rates will have to be paid when negotiations for renewal of contracts commence. Quotations are based on best Rubio ore at 22s. 6d., ex ship Tees. Inquiry for blast-furnace coke is somewhat better, but purchases for local use keep within narrow limits. Good average qualities are in the neighbourhood of 17s. 6d. delivered at works on the North-East Coast.

Manufactured Iron and Steel.

Encouraging accounts are given of the manufactured iron and steel trade. Business is showing a steady expansion in most departments, and values all round are steadily firm. Demand for semi-finished steel continues good. Prospect of activity at the shipyards promises a much-needed increase of employment in one or two steel works departments, and marine engine works are also feeling the benefit of recently placed orders for steamers. Constructional engineers are turning out heavy tonnages, though new business is not coming forward too freely; and manufacturers of sheets of all kinds are running their plant at almost full capacity.

Coal Trade Proceeds and Costs.

The latest ascertainments as to the proceeds and costs of the coal industry in Northumberland and Durham indicate that there is a gratifying increase in financial results from the working of the pits in both counties. Trading in October is covered by the reports, which would, but for the operation of the county minimum percentage on basis wages, determine miners' wages in the present month. For Durham, the percentage on basis wages in December would be 29·39, as compared with 16·20 per cent. in November, an increase of 13·19 per cent. The county minimum is 65 per cent., and therefore the owners have to make up a deficiency this month of 35·61 per cent. The percentage on basis wages this month in Northumberland would be 5·54, as compared with minus 5·45 per cent. in November, which shows an improvement of 9·99 per cent. The deficiency to be made up by the owners is 35·46 per cent., as the county minimum is 40 per cent. The improvement in the ascertainments is due to a more regular production in Durham and a slightly higher price for fuel in Northumberland.

The Coal Trade.

There is a generally brighter outlook in the Northern coal trade. The milder weather is allowing stemmed tonnage to come forward freely, and for prompt loadings fitters for all grades report their booked situation as encouraging, and the full current output is being rapidly cleared off. Bookings to the end of the year are recorded as of satisfactory volume, and any additional business can only be placed where merchants can stem tonnage to fit the individual positions. Northumberland producers of best large steams have little to trouble them as regards orders, and if the weather continues favourable, shipments should be brisk up to the holiday interlude. Best steams for December can easily command 14s. 3d., and second qualities are firm at 13s. 3d. to 13s. 6d. Steam smalls have been quiet for some time, but they are beginning

to receive more notice at the present range of prices. Prime smalls are 9s. to 9s. 3d. Durham gas coals are becoming more favourably placed, and slowly improving in price. Best qualities are heavily booked at 14s. 9d., with seconds at 13s. 3d. to 13s. 6d. Bunkers and coking fuels have improving prospects. Whilst the prompt trade in coke has been disorganised by tonnage delays, the position for the rest of the month is quite favourable. Makers of all grades report a well-filled order book, and direct quotations remain at firm figures. Gas coke is 18s. 6d. to 19s.; patent oven coke, 26s. to 28s. 6d.; special foundry cokes, 23s. to 26s. 6d.

SCOTLAND.

(From our own Correspondent.)

Shipbuilding.

DURING the month of November twelve vessels of 56,602 tons aggregate were launched from Clyde yards, bringing the eleven months' total for the river up to 180 vessels of 555,260 tons aggregate, which is the fourth highest since the year 1904, excluding the war years. Included amongst the vessels launched were the following:—"Northern Prince," twin-screw motor ship, 11,200 tons, built for the Prince Line, Ltd., London; "Athelduke," twin-screw motor tanker, 9000 tons, for the United Molasses Company, Ltd., London; "Manunda," twin-screw passenger and cargo steamer, 9000 tons, for the Adelaide Steamship Company, Ltd., Port Adelaide, Australia; and the "Vacuoline," steam tanker, 8650 tons, for the Vacuum Oil Company, Ltd., London. The number of fresh contracts announced during November was unusually large, and an important feature was the number of general cargo-carrying vessels of the high-class tramp type. Altogether the orders announced aggregate twenty-four vessels of round about 150,000 tons deadweight. The most important was, of course, the order for the Canadian Pacific liner "Empress of Britain," of 40,000 tons gross. The result of these contracts will be a steadily increasing activity at the yards from now until the early spring at least, and although perhaps a trade revival is hardly indicated, there has been at least a good step in the right direction, which must have a certain effect on allied industries.

Steel and Iron.

Though perhaps hardly justified by the amount of business passing meantime, there is undoubtedly a better tone in the steel and iron trades, probably due to the large number of shipbuilding contracts already referred to, which should prove beneficial to the heavy steel makers. Heavy steel has, in fact, been a shade busier of late, both on home and export account. Light steel sheet and galvanised varieties are meeting with a good turnover, and makers have a number of orders on hand. Makers of butt-welded and hot-rolled tubes continue active. The demand for re-rolled steel is fully maintained, and makers have not so far been compelled to purchase home billets, blooms, &c., to any great extent, supplies from abroad having been comparatively well maintained. Re-rolled steel remains firm round about £7 15s. per ton, home or export. Bar iron has a poor market, and the same may be said of pig iron.

Exports and Imports.

During the past week 12,200 tons of iron ore, 1700 tons of steel and iron, and 700 tons of pig iron were unloaded at Glasgow Harbour. During the same period shipments of steel and iron products totalled 3500 tons, and of pig iron 807 tons.

Coal.

During the stormy weather shipments of coal have been interfered with owing to irregular arrivals of steamers, and the shortage of tonnage has been so pronounced in certain districts that production has been curtailed until some improvement takes place. The collieries as a rule are comparatively well placed for orders, and show no inclination to quote lower prices, consequently exporters are doing practically nothing in the way of forward business, and speculative buying is practically unknown meantime. Best Lanarkshire splints, Fifeshire first-class steams, and Lothians steams are all difficult to obtain for prompt shipment; washed nuts are rather irregular. Trebles are comparatively firm in all districts, but doubles are generally weak. Aggregate shipments amounted to 213,652 tons, against 206,215 tons in the preceding week and 252,766 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Conditions.

THE conditions in the steam coal trade are undoubtedly better. The improvement has been brought about by the fact that tonnage which was delayed by bad weather has now arrived, and there is loading pressure at the docks. This was not altogether unexpected, and though some collieries may have more tonnage on hand than they can conveniently deal with, it is a state of affairs to be welcomed more than is a shortage of ready steamers. It is a long time since the number of waiting steamers exceeded the number of idle appliances. About the middle of last week the number of tips unemployed at the various docks was just over thirty, but by Saturday this figure was reduced to fifteen, while nine steamers were waiting to get into berth. As the result of arrivals over the week-end, the position was even better, as on Monday there were only five tips idle, whereas there were twenty-five vessels waiting. Since then the position has eased off and the number of waiting steamers has more closely approximated the vacant berths available. It is impossible to say whether the more satisfactory conditions prevailing are likely to continue for long, though the position of the collieries should remain fairly good up to the Christmas holidays. The total shipments from this district last week were a shade better than in the preceding week, the figures being just over 412,000 tons, as against rather more than 382,000 tons. There is room for considerable expansion in operations, though the shipments this week should mark a further advance. Unfortunately, although reports are current of a fair amount of business having been done ahead, operations for early loading appear to be quieter. Still, a fair number of orders are held by exporters. It is understood that the British Admiralty authorities have bought their requirements over 1929, the total being between 200,000 and 300,000 tons. This is, however, purely a market estimate, and may be wide of the mark. If the figures are correct, then the authorities have bought even less than usual, as it is understood that their purchases over the current year were between 300,000 and 400,000 tons. Reports are also current that several of the firms owning foreign coaling depôts have effected purchases of good steam large coals, amounting to round about a million tons at a price of 17s. 9d. per ton, these coals being for shipment over next year. The Portuguese State Railways have also bought about 30,000 tons of large and small coals for delivery at the end of this year and early next, while the Spanish naval authorities are in the market for about 7000 tons of Welsh coals for shipment this month.

Regulation of Coal Production.

The Executive Committee of the South Wales Coal Marketing Association has completed its scheme for the regulation of coal output, and submitted it to a meeting of the coalowners on Tuesday, though at the time of writing it was not known what the decision was. The probabilities are, however, that no definite decision was come to, and fears are entertained in many quarters that no time will have to be lost if the scheme is to be brought into operation from the beginning of January, as is proposed. The main idea of the scheme is to remove internal difficulties which have been experienced in the operation of the minimum schedule and to bring about greater equality of treatment as between colliery and colliery. The agreement which has to be entered into is fixed for a period of a year and may be continued indefinitely by special resolution, but one of the principal conditions of the operation of the scheme is that there must be a membership producing at least 85 per cent. of the output, excluding anthracite, in the quarter ended September 30th last. The members of the scheme will have their quarterly quota fixed, and provision is made that those who produce in excess of the permitted figure will be fined 2s. 6d. per ton, while collieries which produce less than their allocated quantity will receive 2s. per ton, provided the causes for the under-production come within the conditions laid down. The contribution of the members to the Association is to be ¼d. per ton, and the conditions of the scheme will enable the Association to enter into working arrangements with other coalfields, in order that there shall be co-operation and a co-ordination of the marketing schemes which have been adopted in other areas. The deed which members have to sign is voidable unless it is accepted in writing by the 15th inst.

LATER.

South Wales coalowners at the meeting on Tuesday considered the scheme for the regulation of output and expressed themselves in favour of it, although they could not commit their individual companies to it. It was decided that every colliery company in the coalfield which employs more than fifty workmen should be asked to signify its assent to the scheme not later than the 15th inst., so that it may come into operation on January 1st next.

Coalfield Wages.

South Wales coalowners have applied for a revision of the existing wages agreement. This agreement, which was fixed for a period of three years, and was arranged in 1926, provides for a minimum wage of 28 per cent. on the 1915 standard rates and a subsistence wage for adult workers of 8s. 0¾d. per shift. The owners have now applied that the minimum wage rate shall be 20 per cent., and the subsistence wage shall be reduced to 7s. per day for married workers. Since the coalowners decided upon this step, the Executive Committee of the South Wales Miners' Federation has met and decided to repeat its last year's application, viz., that the minimum percentage shall be increased from 28 to 35 per cent. and the subsistence allowance from 8s. 0¾d. to 8s. 6d. per day, to apply to all workmen over 21, whether they are married or otherwise, and that a flat rate increase of 6d. per day be given to employees between the ages of 16 and 21 years. A meeting of the Conciliation Board to consider these proposals has been fixed for the 10th, and if no agreement is come to, the matter will be referred to the independent chairman, Sir Francis Taylor.

Coalfield Audit.

The report of the joint accountants of the South Wales Conciliation Board for the three months, August, September, and October, certifies that the general wage rate payable under the agreement is 10·42 per cent. below the 1915 standard rates. This compares with a certified percentage of 11·08 below the 1915 standard rates in the previous three months. The agreement, however, provides for the payment to the workmen of a minimum percentage of 28 per cent. above the 1915 standard rates. The actual trading loss of the industry in the three months ending October amounted to £755,153, equal to 1s. 6¾d. per ton on the total quantity of coal raised, compared with a loss in the previous three months of £805,372, equal to 1s. 6·74d. per ton. The aggregate loss on the production of coal under the present agreement which was entered into in December, 1926, has been £4,462,818.

New Ships.

Sir Wm. Reardon Smith, of Cardiff, has contracted with Wm. Gray and Co., Ltd., West Hartlepool and Sunderland, for the construction of six cargo steamers totalling about 52,000 tons deadweight, to be fitted with coal-burning triple and quadruple-expansion engines with up-to-date boilers by the Central Marine Engine Works of the builders. The capital outlay represents about £500,000, some of which will be spent in Cardiff.

Docks Facilities.

The Great Western Railway Company has decided to postpone the closing of the six tips on the west side of the East Dock at Cardiff to the 10th inst. The Cardiff Pilots' Association and the tippers and traffic men at Cardiff are opposing the proposed action of the company, while the coalowners have appointed a deputation to wait on Sir Felix Pole this week regarding the matter. The Parliamentary Committee of the Cardiff Corporation has considered the position, and has appointed the Lord Mayor and the Town Clerk to have an interview with the general manager and his directors. The Parliamentary Committee considers that the proposed action of the company is in violation of the pledge given by the company to the Corporation in 1921, at the time when the grouping of railways was being contemplated. The letter which the Corporation received stated that "In all matters affecting the various towns and docks the aim and object will be to hold the balance evenly between the various interests. In furtherance of this policy the Great Western Company will maintain in a full state of efficiency the tipping and other shipping appliances of Cardiff docks." The contention of the Parliamentary Committee and others who are opposing the proposed action of the company is that if economy is to be effected it should be done all round, and that Cardiff should not suffer at the expense of other centres in this district.

Current Business.

The tone of the market is better in all directions. The docks are well supplied with tonnage, and most of the collieries are quite busy and cannot stem any further quantities of coal for early loading. For some qualities collieries are asking 3d. more than the prices they have obtained recently. Sized coals are especially firm. Coke and patent fuel remain without material alteration, but pitwood is easier at round about 27s. 6d.

CONTRACTS.

VICKERS-ARMSTRONGS, Ltd., have received an order for three sets of endless rope haulage gears arranged for driving by electric motors. The capacity of each haulage is 600 tons at 75ft. per minute.

ALFRED HERBERT, Ltd., informs us that its licensee in Belgium, *i.e.*, Soc. Anon. Ateliers J. Hanrez, Monceau-sur-Sambre, has secured an order for firing five Brouhon type boilers at the Mariemont-Bascoup Collieries, Mariemont, Belgium. They are to be fired by Atritor unit pulverisers.

BALDWINS, Ltd., of 67, Queen Victoria-street, London, E.C. 4, have received an order for galvanising approximately 12,000 tons of material for the South-Eastern electricity scheme. It is stated that this is the largest contract for galvanising of its kind that has ever been placed. It will give employment to about 150 men for three years.

RUSTON AND HORNSBY, Ltd., of Lincoln, have just received an order from the London Brick Company and Forders, Ltd., for an electrically-operated shovel which will be the largest excavator employed in any brickworks in the world. The machine will weigh approximately 380 tons and will carry a 7½ cubic yard bucket and a jib 90ft. long. It will deal with 200 tons of clay per hour.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. R. BORLASE MATTHEWS, M.I.E.E., has been elected as a member of Council of the Royal Agricultural Society of England.

AT a meeting of the board of directors of the Scottish Tube Company, Ltd., held on November 30th, 1928, Mr Henry J. Rhodes was unanimously appointed chairman of the company in succession to the late Mr. Andrew Eadie.

RUSTON AND HORNSBY, Ltd., of Lincoln, ask us to announce that they are advised by their agents in Madras—Massey and Co., Ltd.—that at the recent Industrial Exhibition, which opened in Mysore City on November 15th, a gold medal award was secured by a "Ruston" No. 4 universal excavator, and a further gold medal was awarded for a "Ruston" crude oil road roller.

ALEX. TURNBULL AND CO., Ltd., of Bishopbriggs, Glasgow, ask us to announce that they have appointed Steam Plant Accessories, Ltd., 38, Victoria-street, London, S.W. 1; Messrs. E. E. Baker and Co., 9, Albert-square, Manchester; and Mr. Jas. W. Wilkinson, 14, Hammond-drive, Erdington, Birmingham, to represent them in the London, Manchester, and Birmingham districts respectively.

THE DETRICK ARCH COMPANY, Ltd., asks us to announce that it has taken over from the Underfeed Stoker Company, Ltd., all the rights for the design, manufacture and sale of all flat-suspended arches and roofs and furnace walls constructed under the patent rights of the M. H. Detrick Company in Great Britain and the British Empire—excluding Canada. It has also acquired the rights of design, manufacture and sale of Beco boiler baffles for the same countries. The operations of the Detrick Arch Company will be under the management of Mr. J. K. Mann, formerly with the M. H. Detrick Company, of Chicago.

THE ASSOCIATION OF CONSULTING ENGINEERS.—The dinner of the Association of Consulting Engineers was held at the St. Stephen's Club, Westminster, on Wednesday last, December 5th, under the chairmanship of Mr. H. Howard Humphreys, M. Inst. C.E., M.I. Mech. E., who is also Chairman of the Committee of the Association. As usual, the evening proved to be most enjoyable. There seemed to be an even larger number of members and guests present than on former occasions, and the spirit of *camaraderie*, to which we have before referred as being specially noticeable at these gatherings of the Association, was just as much in evidence as ever. As showing the concern felt by all those present at the illness of the King, it is worth putting on record that his Majesty's health was drunk twice during the evening—once just following the conclusion of the banquet, and, later, when the chairman had received and read out the evening bulletin. An innovation in the toast list was the introduction of "Local Government," which was responded to by the Mayor of Westminster.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
(1) Native	17/- to 19/-
(1) Spanish	21/-
(1) N. African	21/-
N.E COAST—	
Native	18/- to 21/-
Foreign (c.i.f.)	22/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	3 14 0	—
No. 1 Foundry	3 15 0 to 3 16 0	—
No. 3 Foundry	3 11 0	—
N.E. COAST—		
Hematite Mixed Nos.	3 11 0	3 11 0
No. 1	3 12 0	3 12 0
Cleveland—		
No. 1	3 8 6	3 8 6
Silicious Iron	3 8 6	3 8 6
No. 3 G.M.B.	3 6 0	3 6 0
No. 4 Foundry	3 5 0	3 5 0
No. 4 Forge	3 4 6	3 4 6
Mottled	3 4 0	3 4 0
White	3 4 0	3 4 0
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	—	—
North Staffs. Forge	—	—
„ „ Foundry	3 2 6	—
(3) Northampton—		
Foundry No. 3	2 15 6 to 2 16 6	—
Forge	2 11 6 to 2 13 6	—
(3) Derbyshire—		
No. 3 Foundry	3 0 0	—
Forge	2 15 0 to 2 18 0	—
(3) Lincolnshire—		
No. 3 Foundry	3 0 6	—
No. 4 Forge	2 17 6	—
Basic	3 0 0	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
	4 0 0 (a)	—
Hematite Mixed Nos.	4 2 6 (b)	—
	4 5 6 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 5 0	—
Common Bars	10 5 0	—
Best Bars	10 15 0	—
Double Best Bars	11 5 0	—
Treble Best Bars	11 15 0	—
LANCS.—		
Crown Bars	10 0 0	—
Second Quality Bars	9 10 0	—
Hoops	13 0 0	—
S. YORKS.—		
Crown Bars	10 10 0	—
Best Bars	11 0 0	—
Hoops	12 10 0	—
MIDLANDS—		
Crown Bars	9 2 6 to 10 0 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 12 6 to 8 17 6	—
Gas Tube Strip	10 15 0 to 10 17 6	—

STEEL. (d)

	(6) Home. £ s. d.	(7) Export £ s. d.
(5) SCOTLAND—		
Boiler Plates	10 10 0	10 10 0
Ship Plates, ½in. and up	8 7 6	7 12 6
Sections	7 17 6	7 2 6
Steel Sheets, ¼in.	8 15 0	8 12 6
Sheets (Gal.Cor. 24 B.G)	13 10 0 .. 13 12 6	to 13 15 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 7 6	—
Angles	7 17 6	—
Boiler Plates	12 15 0	—
Joists	7 17 6	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	7 12 6	—
Soft Billets	6 15 0	—
N.W COAST—		
BARROW—		
Heavy Rails	8 0 0	—
Light Rails	8 5 0 to 8 10 0	—
Billets	6 15 0 to 9 15 0	—
MANCHESTER—		
Bars (Round)	8 17 6	—
„ (Small Round)	8 0 0 to 8 2 6	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 12 6 to 8 17 6	—
„ (Lancs. Boiler)	9 10 0 to 9 15 0	—
SHEFFIELD—		
Siemens Acid Billets	9 0 0	—
Hard Basic	8 12 6	—
Intermediate Basic	6 17 6 and 7 12 6	—
Soft Basic	6 12 6	—
Hoops	9 0 0	—
Soft Wire Rods	7 12 6	—
MIDLANDS		
Small Rolled Bars	7 15 0 to 8 0 0	—
Billets and Sheet Bars	6 7 6 to 6 10 0	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	—
Galv. Sheets, f.o.b. L'pool	13 10 0 to 13 12 6	—
Angles	7 17 6	—
Joists	7 17 6	—
Tees	8 17 6	—
Bridge and Tank Plates	8 12 6	—
Boiler Plates	11 0 0	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	18/- to 18/1½
Block Tin (cash)	239 0 0
„ (three months)	237 5 0
Copper (cash)	68 11 3
„ (three months)	68 18 9
Spanish Lead (cash)	21 12 6
„ (three months)	21 18 9
Spelter (cash)	26 1 3
„ (three months)	26 6 3
MANCHESTER—	
Copper, Best Selected Ingots	74 7 6
„ Electrolytic	75 10 0
„ Strong Sheets	98 0 0
„ Tubes (Basis Price), lb.	0 1 1½
Brass Tubes (Basis Price), lb.	0 1 0½
„ Condenser, lb.	0 1 2½
Lead, English	23 0 0
„ Foreign	21 17 6
Spelter	26 10 0
Aluminium (per ton)	£107

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/10 per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 10 0	7/6
„ „ 6 p.c. to 8 p.c.	£20 10 0	7/-
„ „ 8 p.c. to 10 p.c.	£20 0 0	6/-
„ „ Specially refined		
„ „ Max. 2 p.c. carbon	£33 0 0	12/-
„ „ „ 1 p.c. carbon	£37 0 0	15/-
„ „ „ 0·70 p.c. carbon	£42 0 0	17/-
„ „ „ carbon free	1/- per lb.	
Metallic Chromium	2/7 per lb.	
Ferro Manganese (per ton)	£13 15 0 for home	
	£13 10 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£12 0 0 scale 5/- per unit	
„ „ 75 p.c.	£19 0 0 scale 6/- per unit	
„ Vanadium	14/- per lb.	
„ Molybdenum	4/3 per lb.	
„ Titanium (carbon free)	1/2 per lb.	
Nickel (per ton)	£170 to £175	
Ferro-Cobalt	9/- per lb.	

FUELS.

SCOTLAND.

(*Prices not stable.*)

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	14/-
„ „ Ell	16/-
„ „ Splint	16/3 to 17/-
„ „ Trebles	14/9 to 15/6
„ „ Doubles	13/9 to 14/-
„ „ Singles	12/6 to 12/9
AYRSHIRE—	
(f.o.b. Ports)—Steam	13/6
„ „ Jewel	16/6
„ „ Trebles	16/-
FIFESHIRE—	
f.o.b. Methil or Burntisland—Steam	12/9 to 13/3
Screened Navigation	18/-
Trebles	15/6 to 16/6
Doubles	13/3 to 13/6
Singles	12/9
LOTHIANS—	
(f.o.b. Leith)—Best Steam	13/- to 13/6
Secondary Steam	12/9
Trebles	15/3 to 15/6
Doubles	13/6
Singles	12/9

ENGLAND.

	Export.
(8) N.W. COAST—	
Steams	25/-
Household	38/6 to 51/-
Coke	22/-
NORTHUMBERLAND—	
Best Steams	14/3
Second Steams	13/- to 13/6
Steam Smalls	9/-
Unscreened	11/9 to 12/-
Household	21/- to 27/-
DURHAM—	
Best Gas	14/9
Second	13/3 to 13/6
Household	21/- to 27/-
Foundry Coke	18/6 to 19/6

	Inland.	Export.
SHEFFIELD—		
Best Hand-picked Branch	26/- to 27/6	—
Derbyshire Best Bright House	23/- to 24/6	—
Best House Coal	20/6 to 21/6	—
Screened House Coal	17/- to 18/-	—
„ „ Nuts	16/- to 18/-	—
Yorkshire Hards	14/6 to 16/-	—
Derbyshire Hards	14/6 to 16/-	—
Rough Slacks	8/6 to 9/6	—
Nutty Slacks	4/6 to 6/-	—
Smalls	3/6 to 4/-	—
Blast-furnace Coke (Inland)	13/6 at ovens	—
Furnace and Foundry Coke (Export), f.o.b.		19/- to 19/6

(9) SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Smokeless Large	19/3 to 19/6
Second Smokeless Large	18/- to 19/3
Best Dry Large	18/3 to 18/9
Ordinary Dry Large	17/6 to 17/9
Best Black Vein Large	17/6 to 17/9
Western Valley Large	17/- to 17/3
Best Eastern Valley Large	16/6 to 17/-
Ordinary Eastern Valley Large	16/3 to 16/6
Best Steam Smalls	12/6 to 13/-
Ordinary Smalls	10/6 to 12/-
Washed Nuts	18/- to 24/-
No. 3 Rhondda Large	19/6 to 20/-
„ „ Smalls	14/- to 14/6
No. 2 „ Large	16/- to 16/6
„ „ Through	14/6 to 15/6
„ „ Smalls	11/- to 12/-
Foundry Coke (export)	27/- to 37/-
Furnace Coke (export)	19/- to 21/-
Patent Fuel	20/- to 21/6
Pitwood (ex ship)	27/6 to 28/-
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	34/- to 35/6
Seconds	24/6 to 28/6
Red Vein	22/- to 27/-
Machine-made Cobbles	40/- to 43/6
Nuts	36/- to 43/6
Beans	23/6 to 25/-
Peas	17/3 to 18/-
Breaker Duff	8/- to 8/6
Rubbly Culm	9/6 to 10/-
Steam Coals:	
Large	17/6 to 18/6
Seconds	16/- to 17/-
Smalls	10/- to 12/6
Cargo Through	15/- to 16/-

(1) Delivered. (2) Net Makers' Works. (3) f.o.t. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (a) Delivered Glasgow. (b) Delivered Sheffield.

(c) Delivered Birmingham. (d) Rebate 12/6 joists and 10/- all other materials if home consumers confine purchases solely to British products.

French Engineering Notes.

(From our own Correspondent in Paris.)

The Steel Trade.

THE fact that the lock-out in the Ruhr had little or no effect upon the export demand for French steel is taken as an indication that the situation of steelmakers is less stable than was generally supposed. Of the 10,000,000 tons of steel produced in this country annually about one half is sent abroad, and in the report of one of the big metallurgical companies it is stated that, while the tonnage exported in 1927 was 32 per cent. more than that of the previous year, the value per ton declined by 24 per cent. It may be taken for granted that the declension in value has accentuated during the present year. Under these circumstances the prospects of further competition are not reassuring, particularly now that the United States steel firms have arranged for the creation of a large number of additional sales offices in Europe and elsewhere, and it is partly for that reason that French producers are showing more restraint in the matter of prices, which did not harden even under the influence of the lock-out in the Ruhr.

Barrage Reservoirs.

The Conseil Général de la Seine has completed preliminary arrangements for the construction of the Cure barrage reservoir in the Department of the Yonne. This is the first of the series of reservoirs which it is proposed to form in the upper valley of the Seine with the idea of keeping the level of the river fairly regular at all seasons, by storing water during rainy periods and returning it to the river when the natural flow is small. The artificial lake to be created at Cure is in the nature of an experiment, and, if successful, other similar undertakings will be put in hand. Of the total sum of 20,000,000 francs, which the Cure reservoir is expected to cost, the Department of the Yonne will guarantee one half in return for the right to utilise the hydro-electric energy, while the other half will be divided equally between the State and the Department of the Seine. Upon the effectiveness of the barrage reservoirs will depend the success of the scheme for enlarging considerably the Port of Paris. The construction of basins and the widening of canals at Pantin and St. Denis are being proceeded with, and work is in progress on the Port of Gennevilliers, where all the traffic to and from Havre and Rouen will be centred, so as to avoid unnecessary transport by the Seine through Paris. Unless the reservoirs are effective there will always be a prospect of serious trouble during particularly heavy rainy seasons.

Low Temperature Distillation.

An interesting account of the present state of low temperature distillation was recently given by Professor Roszak before the Société des Ingénieurs Civils de France. He said that the processes employed in different countries aimed either at producing petrol and smokeless fuels, as in England, or in giving a value to lignites, as in Germany, or in utilising more economically dear fuels. That was the situation in France, which wanted primarily petrol and oils, and, to a less extent, smokeless fuels. Of the 72,000,000 tons of coal and lignite consumed in this country last year 16,500,000 tons were employed for high temperature carbonisation, and of the remainder at least 30,000,000 tons of French coal could be utilised by low temperature distillation processes. This would produce 150,000 tons of petrol, 270,000 tons of ordinary oils, and 120,000 tons of lubricating oils. After describing different systems of low temperature carbonisation processes Professor Roszak gave particular prominence to the Hereng system, which, he said, was chiefly noteworthy on account of its economy. Nevertheless, the success of low temperature carbonisation depended upon the home demand being sufficient to absorb all the semi-coke and residual tar. It is expected that a use for this product will be found more particularly in its combination with other materials or the tarring of roads.

Electric Canal Haulage.

Having created an extensive inland port, Strasburg is anxious to secure the greatest possible facilities for accelerating traffic on the canals between the Rhone and the Rhine. In the Department of the Nord, electrical haulage has proved so far satisfactory that it is to be largely extended in the coming year. The Strasburg Chamber of Commerce is carrying out tests of electric haulage, which will be adopted very shortly, but it fears that when the system becomes general it may be taken over by the State, which will eliminate all other haulage methods coming into competition with it. This possibility is regarded as a serious menace to the future of the canal system and particularly to the interests of owners of barges propelled by internal-combustion engines. There is some objection to motor barges on the ground that the wash they make is detrimental to the banks, but competition is desired to prevent canal freights from being raised unduly by anything in the form of a monopoly.

The Navy.

In view of the efforts being made to limit naval armaments, there was a certain amount of Socialist opposition to the voting of credits for the continuance of the programme of naval construction. It elicited an explanation from the Minister of Marine to the effect that while, next to Great Britain, France lost far more ships than any other country during the war, she was the last in the tonnage built since then. At the present moment the tonnage afloat is 488,000 tons, and there are 90,000 tons on the stocks. The number of officers is 1768 and of men 53,000. Since 1920 the programme of naval construction has been carried out systematically with a view of adapting the navy to the country's special needs. The Minister remarked that the new vessels compared favourably in seaworthiness, endurance, speed and armament, with the best ships of the same types in foreign navies.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

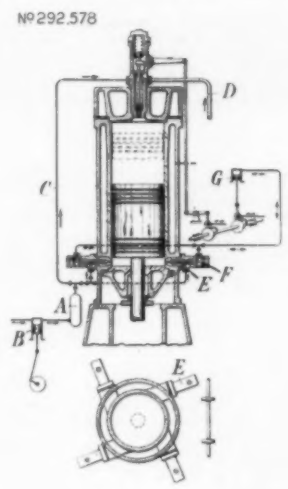
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

292,578. April 12th, 1928.—FUEL INJECTION, Sulzer Frères, Société Anonyme, Winterthur, Switzerland.

In this double-acting engine the top of the cylinder is supplied with fuel by means of compressed air, while the lower side has airless injection. The fuel for both sides is taken from the common accumulator A, which is supplied by the pump B. Fuel for the top of the cylinder goes by the pipe C and highly compressed air by the pipe D. At the bottom of the cylinder there are four tangential fuel valves E E, which, as they are in different positions in relation to the cam shaft, are operated hydraulically by the gear shown at F and G. In explaining the reason for having two types of injection the inventors say:—By the use of these two different types of fuel injection devices it is possible



to retain the advantages of air injection for the upper disc-like combustion chamber while avoiding cooling of the lower annular combustion chamber into which the fuel is injected without the use of air. As a result, the compression pressure in the lower chamber can be reduced and thus the dimensions of this chamber can be increased, enabling the airless fuel injection devices to be better distributed around the larger circumference of the lower chamber. Moreover, airless fuel injection devices are smaller than those using compressed air, so that the openings in the cylinder wall can be of reduced diameter, which produces smaller stresses at the edges of these openings and enables a larger number of injection devices to be provided, resulting in a better distribution of fuel to the lower annular combustion chamber.—*October 25th*, 1928.

SWITCHGEAR.

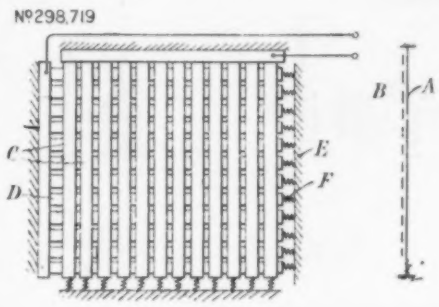
298,701. July 20th, 1927.—IMPROVEMENTS RELATING TO ELECTRIC SWITCHES, Siemens Brothers and Co., Ltd., of Caxton House, Tothill-street, London, S.W. 1, and Frank Baker, of 17, Woodland-terrace, Charlton, London, S.E. 7.

This invention relates more particularly to electric switches of the kind in which a movable contact member is adapted to make contact with more than one fixed contact. The invention is particularly applicable to selectors, pre-selectors and other stepping switches used in automatic and semi-automatic telephone systems and selecting switches used in remote control systems. According to the invention, a coating of chromium is applied to the fixed or movable contacts or both. The coating may be applied by electro-deposition or by any other method which provides for a hard, homogeneous, and closely adhering coating. In the case of stepping switches of the character mentioned the coating is applied preferably to the fixed contacts only and the movable contact is made of some softer metal so that wear takes place chiefly at the contacting surface of the movable member. A contact bank for selecting and stepping switches is made up of levels of contacts separated by layers of insulating material, generally ebonite. The contacts are usually of brass. The contacts are chromium plated and moulded into ebonite. The contacts are pressed into strips of uncured ebonite and are then subjected to the vulcanising curing process. The chromium plated contacts are not affected by the free sulphur as unplated brass contacts would be. Before curing, a number of strips may be superposed and pressed together, so that a composite bank is obtained and solidified by the curing process.—*October* 18th, 1928.

TELEGRAPHS AND TELEPHONES.

298,719. August 4th, 1927.—IMPROVEMENTS RELATING TO ELECTROSTATIC DEVICES FOR THE INTERCONVERSION OF MECHANICAL AND ELECTRICAL OSCILLATIONS, SUCH AS CONDENSER TELEPHONES, The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C. 2, and Reginald Charles Clinker, of "Tryfn," Old Bilton, Rugby.

This invention relates particularly to loud-speaking condenser telephones. If such an apparatus is to produce a sufficient volume of sound for loud-speaking purposes it is desirable to use relatively large electrodes. This, however, presents many practical difficulties, and the invention involves a construction by which the difficulties attendant upon the use of a relatively large movable electrode may be obviated. The principle of the invention, however, may also advantageously be applied to smaller instruments, such as small condenser telephones. At least one of the electrodes is constituted by a number of flexible metallic strips which are arranged side by side in one plane, and each strip is separately tensioned. The strips are, say, 3ft. or 4ft. in length and about 2in. in width. The strips may be of a conducting metal foil, for example, aluminium, and it may be desirable to coat them with varnish or other insulating material in order to prevent the electrodes from short-circuiting when subjected to relatively high potentials. The best results are obtained when the width of the strips relative to the surface of the electrode is such that the damping due to the air layer between the electrodes is an optimum value. A and B represent

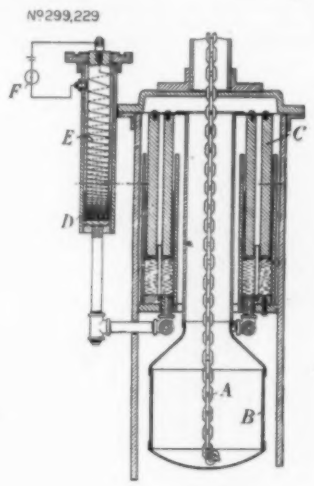


the two plates respectively of an electrostatic loud speaker, each plate made up of strips indicated at C and D respectively. Each strip is rigidly attached at one end to a framework E and tensioned at the other end to the frame by a spring F.—*October 18th*, 1928.

MEASURING AND TESTING INSTRUMENTS.

299,229. December 23rd, 1927.—A GAS HOLDER GAUGE, Electrofio Meters Company, Ltd., Abbey-road, Park Royal, London, N.W. 10.

The chain A is so connected with the upper telescoping part of the gas holder that, as the holder rises, the chain drops and accumulates in the basket B. This basket is supported by

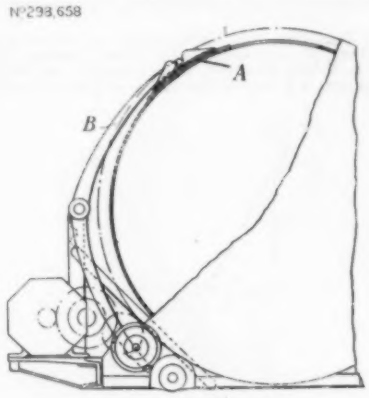


plungers C floating on mercury. As the weight of the chain in the basket increases the floats are depressed and the level of the mercury rises. This rise is communicated to the stand pipe D in which there is an electrical resistance E. The mercury short circuits part of this resistance, according to its level, and an indication of the level is given on the instrument F.—*October 25th*, 1928.

GAS PRODUCERS.

298,658. June 15th, 1927.—COOLING COKE, The Illingworth Carbonisation Company, Ltd., 16, Kennedy-street, Manchester, and S. R. Illingworth, Brynfedwen, Radyr, Glamorganshire.

This invention is concerned with the opening of the doors of coke cooling chambers working in connection with carbonisa-



tion plants, an operation which heretofore has been very arduous for the operators. According to the invention the doors A are opened by being held by the arms B while the chamber is rotated to discharge its contents. The arms are put in place manually and are swung back when not in use. The doors are provided with hand latch plates.—*October 15th*, 1928.

MACHINE TOOLS AND SHOP APPLIANCES.

299,285. June 25th, 1928.—PUNCHING MACHINES, *De Bergue and Co., Ltd., Strangeways Ironworks, Manchester.*

This press is intended for both continuous and intermittent operation. It is familiar in that the ram A operates the tool holder B through the tumbler block C. There is also a notched shaft D in the tool holder, which, by rotation, may be made to engage with the recess E in the ram. This shaft is operated by a handle and may be retained in position by a pawl. When work-

ing continuously the parts are arranged as shown in Fig. 1, and the ram and tool holder act as one. For intermittent work the shaft D is turned as shown in Fig. 2. Then it is only necessary

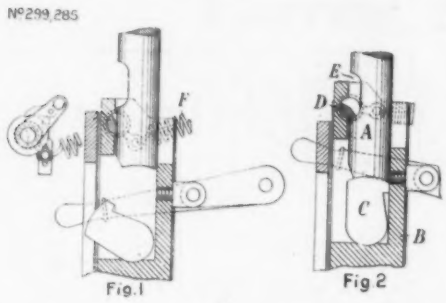


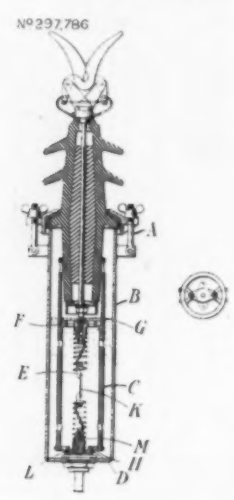
Fig. 1 Fig 2

to raise the tumbler to make a working stroke, while the spring F will turn the shaft to raise the tool holder on the up stroke. The hand lever is for raising the tool holder manually.—*October 25th*, 1928.

MISCELLANEOUS.

297,786. June 28th, 1927.—IMPROVEMENTS IN ELECTRIC FUSES, A. Reyrolle and Co., Ltd., of Hebburn-on-Tyne, Durham, and Walter James Cook, of 1, Carlton-terrace, Low Fell, Gateshead-on-Tyne.

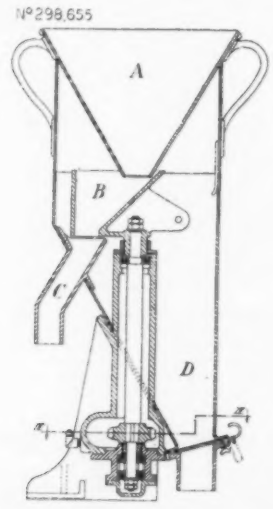
This invention relates to electric fuses of the kind wherein a fusible element is enclosed in a tubular casing, generally although not necessarily, filled with oil. The fuse has within an outer casing, preferably of metal, an inner readily removable liner containing a fuse element held between clips attached directly or through tension springs to end plates resting on shoulders or abutments in the liner, one or both of the end plates being shaped so as to allow quick disengagement from the shoulder or abutment. To replace a fuse after one has blown the swing studs A are loosened and the casing B removed, taking with it



the liner C, end plate D, and the lower fuse clip E, and leaving the upper end plate F, which is a loose fit in the liner, on the plug G. The liner C is then withdrawn from the upper open end of the casing with the end plate D, the small screws attaching that end plate to the abutments H are removed and the end plate and fuse clip taken out of the liner. The top end plate F is then removed from the plug G, and a new length of fuse wire K placed in the clips. The fuse and end plates are then replaced in the liner from the top, the end plate D first being passed through the space between the internal abutments H and then turned and again attached to those abutments. The liner with its fuse is then replaced, so that the plug G engages with the socket in the end plate D. When this has been done, the casing is replaced and the plug F enters the socket M.—*September 28th*, 1928.

298,655. June 11th, 1927.—APPARATUS FOR TAKING SAMPLES OF ORES, W. Dryden, Grimshaw-street Foundry, Preston, and L. Knight, The Croft, Great Saughall, near Chester.

This apparatus is intended for taking samples of ores as they



pass in bulk through the works. The ore is delivered to the hopper A and falls into a rotating scoop B. Every time the scoop passes over the shoot C a sample is taken, while the bulk of the material passes down the main shoot D. The proportion of the sample may be varied by altering the size of the opening of the shoot C.—*October 11th*, 1928.

285,485. February 18th, 1927.—HARD SOLDER FOR GREY CAST IRON, Metallbank und Metallurgische Gesellschaft Aktiengesellschaft, 45, Bockenheimer Anlage, Frankfurt-on-the-Main, Germany.

After pointing out the difficulties which arise in the hardening of a brass solder by means of the addition of nickel, on account of the vapours emitted, and the consequent porosity of the joint, the inventors go on to say that it has now been found that this disadvantage can be overcome by alloying with such nickel-brass alloys silicon in amounts of up to 3 per cent. In many cases a silicon content of 0·5 per cent. is sufficient. The addition of silicon renders the hard solder more fluid and that of nickel renders it harder, so that any desired degree of fluidity and toughness can be attained by suitably mutually adjusting the additions of nickel and silicon. The invention accordingly provides a hard solder consisting of 42 to 60 per cent. of copper, 1 to 10 per cent. of nickel and up to 3 per cent. of silicon, the remainder consisting of zinc. A wire of the following composition has been found particularly suitable, viz., 50 to 53 per cent. copper, 2 to 5 per cent. nickel, 0·2 to 1 per cent. silicon, remainder zinc. The alloys of a composition within the above described limits have the advantage that they can at the same time be easily pressed or extruded so that wires can easily be produced therefrom.—*October 25th*, 1928.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME and PLACE at which the meeting is to be held should be clearly stated.

TO-DAY.

INSTITUTION OF ELECTRICAL ENGINEERS.—First meeting of the recently formed Meter and Instrument Section. Paper, "Load Levelling Relays and their Application in Connection with Future Metering Problems," by Mr. W. Holmes. 7 p.m.

INSTITUTION OF ENGINEERING INSPECTION.—At the Royal Society of Arts, John-street, Adelphi, London, W.C. 2. "The Application of Electro-deposited Metals to Engineering," illustrated by lantern slides and exhibits, by Mr. C. H. Faris. 5.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, Westminster. Informal meeting. "Works Committees," by F. E. Robinson. 7 p.m.

INSTITUTION OF WATER ENGINEERS.—Apartments of the Geological Society, Burlington House, W. (1) "The Consumption and Waste of Water, by Mr. John Bowman, M. Inst. C.E.; (2) "Legal Considerations relating to the Administration of Engineering Contracts," by Mr. E. J. Rimmer, A.M. Inst. C.E.; (3) "The Sandfields," by Mr. A. W. Burtt; (4) "The Corrosive Attack of Moorland Water on Concrete," by Messrs. W. T. Halcrow, M. Inst. C.E., G. B. Brook, F.I.C., M.I.M.M., and R. Preston. 10.30 a.m.

JUNIOR INSTITUTION OF ENGINEERS.—At the House of the Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Presidential address, by Lieut.-Col. J. T. C. Moore-Brabazon. 7.30 p.m.

NORTHAMPTON POLYTECHNIC INSTITUTE.—St. John-street, London, E.C. 1. Annual prize distribution. 7 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Mining Institute, Newcastle-on-Tyne. "Combustion and its Difficulties in Marine Oil Engines," by Mr. K. O. Keller. 6.30 p.m.

SATURDAY, DECEMBER 8TH.

INSTITUTION OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOCIATION.—Visit to Muntz's Metal Company, Ltd., at French Walls, Smethwick. Members should assemble at the works at 9.30 a.m.

NORTHAMPTON POLYTECHNIC INSTITUTE.—St. John-street London, E.C. 1. Annual conversazione. 6.30 p.m.

MONDAY, DECEMBER 10TH.

BRADFORD ENGINEERING SOCIETY.—The Technical College, Great Horton-road, Bradford. "Recent Developments in Economical Steam Generation," by Mr. A. E. Lock. 7.30 p.m.

INSTITUTE OF FUEL.—A joint meeting with the Institute of Transport, at the Institution of Electrical Engineers, Savoy-place, Victoria Embankment, London, W.C. 2. "Fuels—Alternative or Supplementary to Petrol—for Use in Internal Combustion Engines for Road Vehicles." "Liquid Fuels," by Dr. W. R. Ormandy; "Gaseous Fuels," by Monsieur A. Metral. 5.30 p.m.

INSTITUTE OF METALS: SCOTTISH LOCAL SECTION.—In the Rooms of the Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. "Scottish Moulding Sands and their Application to Non-ferrous Casting," by Mr. R. Hudson. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Joint meeting with Institution of the Rubber Industry, Blackfriars Theatre, William-street, London, E.C. 4. "The Tire as an Article of Manufacture and Usage," by Mr. W. H. Paull. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Queen's Hotel, Birmingham. "Experiments on Self-energised Brakes," by Major C. G. Nevatt. 7 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: NORTH-EASTERN CENTRE.—Armstrong College, Newcastle-on-Tyne. "An Introduction to Researches on Circuit Breaking" (Electrical Research Association Report), by Messrs. E. B. Wedmore, W. B. Whitney, and C. E. R. Bruce. 7 p.m.

SURVEYORS' INSTITUTION.—12, Great George-street, Westminster, S.W. 1. "The Recent Rating Acts in Operation," by Mr. F. G. Fleury. 8 p.m.

TUESDAY, DECEMBER 11TH.

ILLUMINATING ENGINEERING SOCIETY.—At the E.L.M.A. Lighting Service Bureau, 15, Savoy-street, Strand, W.C. 2. "The Use of Electric Light for Advertising Purposes," by Mr. H. Lingard. 6.30 p.m.

INSTITUTE OF MARINE ENGINEERS.—85–88, The Minories, Tower-hill, London, E. 1. "Practical Refrigeration for Ships," by Mr. A. Greenfield. 6.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Broadgate Café, Coventry. "Experiments on Self-energised Brakes," by Major C. G. Nevatt. 7.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—The North British Hotel, Edinburgh. "The Electrification of the Pietermaritzburg-Glencoe Section of the South African Railways," by Mr. F. Lydall, will be read by Mr. W. Hawthorne. This paper will be preceded by "A Note on the First Electric Railway in Scotland," by Mr. D. S. Munro. 7 p.m.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.—At the House of the Royal Society of Arts, John-street, Adelphi, W.C. 2. "Madagascar and its Oil Lands," by Dr. Arthur Wade. 5.30 p.m.

MANCHESTER GEOLOGICAL AND MINING SOCIETY.—Queen's Chambers, 5, John Dalton-street, Manchester. "The Manufacture of Electric Detonators," by Mr. T. Campbell Futers. 4 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. "Diamonds," Lecture IV., by Sir Wm. Bragg, F.R.S. 5.15 p.m.

SHEFFIELD METALLURGICAL ASSOCIATION.—198, West-street, Sheffield. "Works Tests of Refractories and Service Results," by Mr. R. J. Sarjant. 7.30 p.m.

WEDNESDAY, DECEMBER 12TH.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. 1. Informal meeting. Subject for discussion, "Methods of Reducing Temperature in Deep Mining Work," by Mr. James Whitehouse. 6 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. "Applications of Electricity to Medical Practice," by Mr. G. G. Blake. 8 p.m.

THURSDAY, DECEMBER 13TH.

INSTITUTE OF METALS: BIRMINGHAM LOCAL SECTION.—In the Engineers' Club, Waterloo-street. "Magnesium Alloys for Engineering," by Mr. E. Player. 7 p.m.

INSTITUTE OF METALS: LONDON LOCAL SECTION.—Joint meeting with the Institute of British Foundrymen, in the Rooms of the Society of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, S.W. 1. "Aluminium-silicon Alloys: Their Properties and Some Applications," by Mr. R. B. Decley. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Watergate House, Adelphi, London, W.C. 2. London graduates. "The Future of Automobile Engineering," by Mr. H. G. Dunn. 7.25 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Cavendish Café, Cornmarket, Derby. Graduates. "Recent Improvements in Omnibuses," by Mr. K. B. Powell-Lee. 7.30 p.m.

INSTITUTION OF CIVIL ENGINEERS: YORKSHIRE ASSOCIATION.—Hotel Metropole, Leeds. "Notes on Power Station Construction," by Mr. A. H. D. Markwick. 7.30 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS (LONDON).—Denison House, 296, Vauxhall Bridge-road, Westminster, London, S.W. 1. "Some Points of Common Interest in Rolling Stock and Permanent Way," by Mr. H. Holcroft. 6 p.m.

OPTICAL SOCIETY.—At the Imperial College of Science and Technology, Imperial Institute-road, South Kensington. "The Measurement of Axial Aberrations of Telescopic Systems of Small Magnification," by Mr. B. E. Mourashkinsky and Miss M. Savostianoff; "Note on Skew Pencils Traversing a Symmetrical Instrument," by Mr. T. Smith. 7.30 p.m.

FRIDAY, DECEMBER 14TH.

CHEMICAL ENGINEERING GROUP.—In the Rooms of the Chemical Society, Burlington House, Piccadilly, W. 1. "The Air Lift as a Chemical Engineering Appliance," by Mr. Norman Swindin. 8 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH, BURNLEY SECTION.—Municipal College, Ormerod-road, Burnley. "Comparison of English and French Moulding," by Mr. S. Stanworth. 7.15 p.m.

INSTITUTE OF METALS: SHEFFIELD LOCAL SECTION.—In the Non-ferrous Section of the Applied Science Department of the University, St. George's-square. "Chromium Plating," by Mr. L. Wright. 7.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, Westminster, S.W. 1. General meeting. "Cutting Tools Research Committee Report on Machinability," by Mr. E. G. Herbert. 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. "Locomotive Boiler Washing Plant," by Mr. E. J. M. South. 7.30 p.m.

POLYTECHNIC ENGINEERING SOCIETY.—Fyrie Hall, The Polytechnic, Regent-street, London, W. 1. Annual conversazione. 7.30 p.m.

SATURDAY, DECEMBER 15TH.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH, JUNIOR SECTION.—College of Technology, Sackville-street, Manchester. "The Application of the Microscope to the Study of Metals and Alloys," by Mr. G. Mohn. 7 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Students' visit to the Weybridge works of Vickers (Aviation), Ltd.

MONDAY, DECEMBER 17TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Royal Technical College, Glasgow. "Recent Developments in the Study of the Fatigue of Materials," by Dr. H. J. Gough. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—The College, Loughborough. Graduates. "Servo-Equipment," by Mr. C. K. Spied. 7 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Bolbec Hall, Newcastle-on-Tyne. Informal meeting in the Institution Library. Subject for discussion, "Could the Method of Conducting Measured-mile Trials be Improved?" To be introduced by Mr. John Neill. 7.15 p.m.

RAILWAY CLUB.—57, Fetter-lane, London, E.C. 4. "Recent Developments in Main Line Electrification in France," by Mr. J. Pelham-Maitland. 7.30 p.m.

TUESDAY, DECEMBER 18TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Broadgate Café, Coventry. "Automobile Brakes," by Mr. L. H. Dawtrey. 7.15 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Engineering and Scientific Club, Queen-street, Wolverhampton. "Modern Problems of Engine Lubrication," by Mr. L. H. Pomeroy. 7.30 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, London, S.W. 1. "The Reconstruction of the New Holland Pier," by Mr. J. H. Nicholson. 6 p.m.

WEDNESDAY, DECEMBER 19TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Queen's Hotel, Birmingham. Graduates. "Two-stroke Engines," by Mr. W. G. Copestake. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Engineers' Club, Albert-square, Manchester. "The Design of a Town Carriage," by Mr. J. O. H. Norris; "Suggestions relating to the Design of Automobiles," by Mr. F. H. Paul. 7 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, London, S.W. 1. Students' meeting. "The Harbour Improvement Scheme at St. Peter Port, Guernsey," by Mr. I. W. G. Freeman. 6.30 p.m.

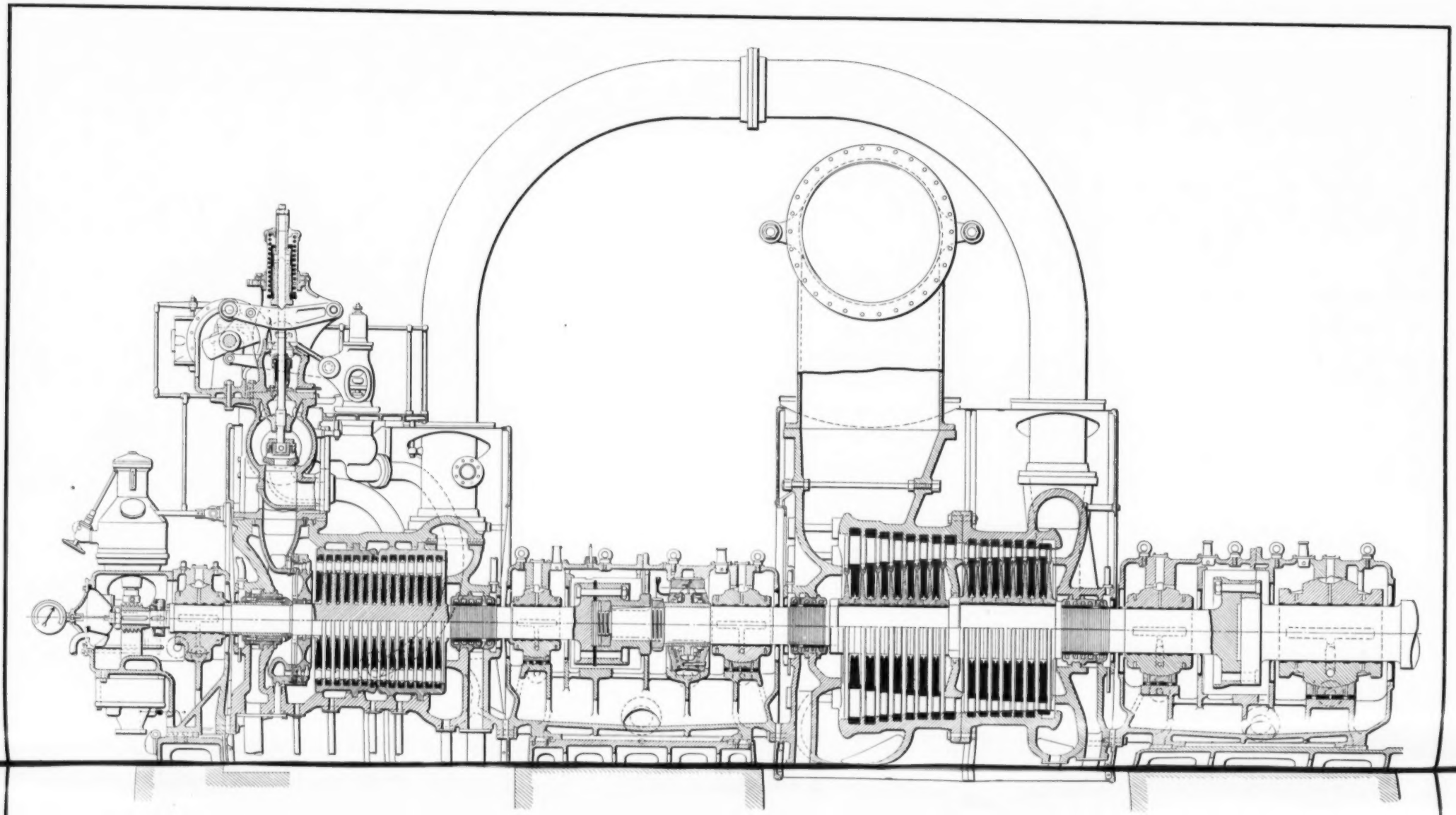
RAILWAY CLUB.—Manchester Hotel, Aldersgate-street, E.C. 1. Twenty-second annual dinner. 7.30 p.m.

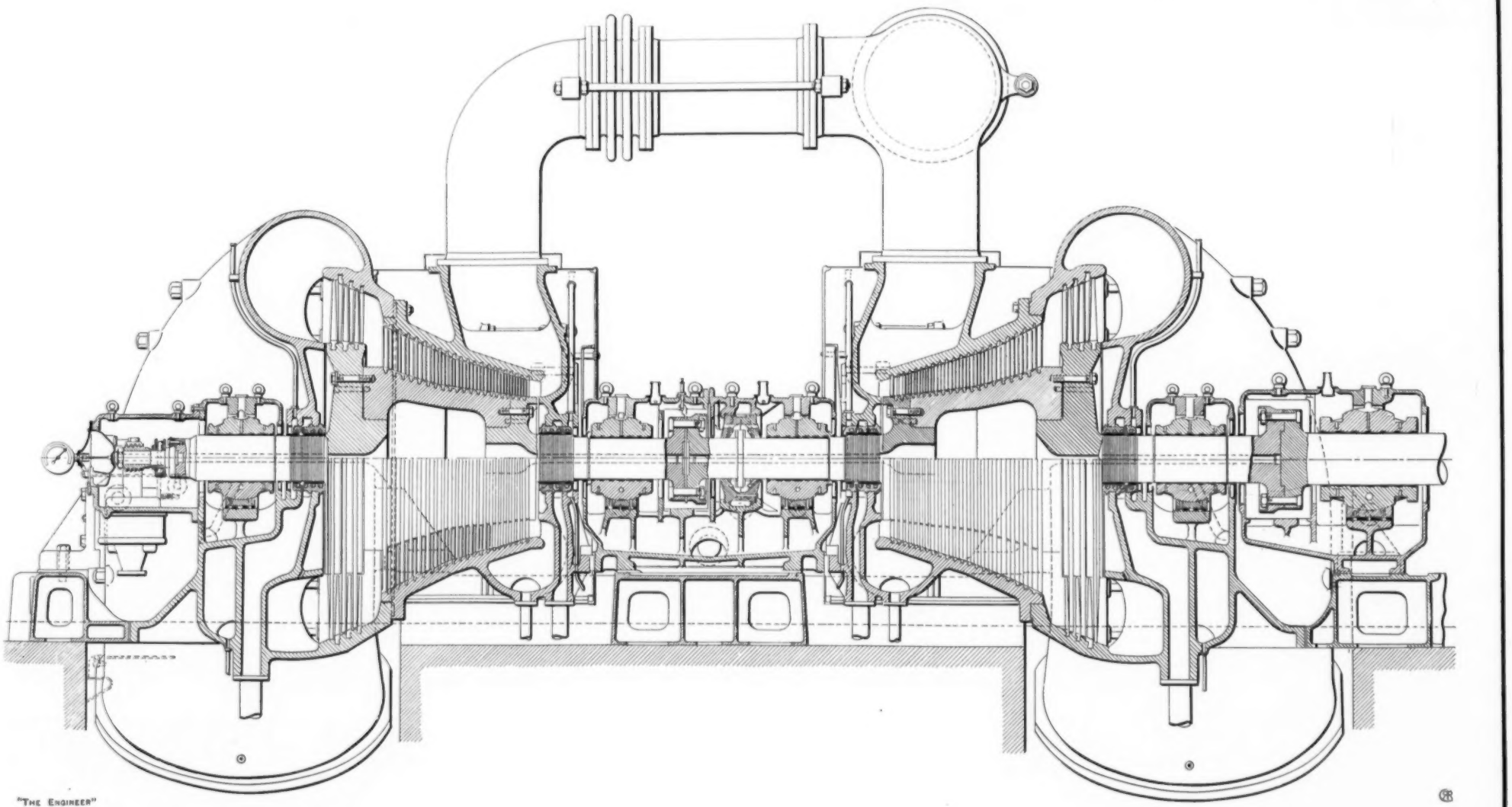
FRIDAY, DECEMBER 21ST.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. Informal meeting. "Oils for Cutting and Quenching Purposes," by Mr. C. H. Hudson. 7.30 p.m.

KLINGENBERG POWER STATION—80,000 kW STEAM TURBINES

ALLGEMEINE ELEKTRICITATS GESELLSCHAFT, BERLIN, ENGINEERS





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